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WRAPPER TOBACCO

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TWENTY-NINE PLATES AND EIGHT TEXT FIGURES

The production of wrapper leaf tobacco has become so specialized a phase of the tobacco industry of the world that it might well be considered a distinct industry by itself. In the past, cigars were wrapped with the same materials used for filler, but the advance of civilization and ensuing refinements in taste made people the world over more critical in their demand for new and better things. At present cigars wrapped with fine, delicate, and light wrappers are in demand. The result is that some countries began to specialize in the production of the desired product, and to-day the Sumatra, the Cuban Havana, the Porto Rican, the Connecticut, and the Georgia wrapper tobaccos are the standard cigar wrappers, produced through highly specialized methods of culture.

The famous Sumatra wrapper, a product of long and painstaking research on acclimatization, breeding, and intensive culture, is arbitrarily accepted as the standard by which all wrapper leaves are judged. The Cubans themselves, notwithstanding the universally high reputation of their "Havanas," admit the

superiority of the Sumatra to their own wrappers. Also, in spite of the world-wide distinction given to the United States cigar wrappers, the American manufacturers prefer the Sumatra for wrapping their high-grade cigars.

Practically in every cigar tobacco country efforts have been made and are being extended towards improving wrapper tobacco and the methods of its production in order to meet the demands and dictates of fashion among smokers.

Many articles have been published in different countries wherein wrapper tobacco is discussed in a greater or lesser degree, but apparently no paper has as yet appeared that is devoted to a general survey of this important industry. This paper, therefore, is to serve principally as a brief yet comprehensive treatise on this subject, with special reference to the point of view of the growers. Its preparation necessitated a thorough search of available literature to bring together many scattered but valuable bits of pertinent information.

It must be stated in passing that this paper is the outcome of an incessant demand for a comprehensive guide on wrapper tobacco culture both in and outside the Philippine Islands. It is hoped that this volume will serve such a purpose.

I. MATERIALS FOR CIGAR MANUFACTURE AND THE SOURCES OF WRAPPER

Leaf materials for cigar manufacture.—In cigar manufacture three distinct tobacco products furnish the materials; namely, the filler, the binder, and the wrapper. The first and the last are specialized products, that is, each is grown specially for the purpose for which it is intended. Filler tobacco, as the word indicates, is raised to form the main body of the cigar. The leaves, therefore, must be of good and rich aroma and of agreeable flavor, and must burn freely and evenly. Binders are used to cover or bind the fillers preparatory to final wrapping. For this purpose usually discarded wrapper or finer filler leaves are used.

The wrapper material is grown specially for wrapping cigars. It must, therefore, be uniform in color and free from holes. It must be very elastic, so that it can be wrapped smoothly and tightly around the cigar. The color must be light, the shape of the leaves almost round, and large enough to yield an optimum number of wrappers per leaf or per weight. It should have the same aroma and flavor as the filler, or, if not

fulfilling this requirement, should at least be neutral so that it will not in any way mar the desirable qualities of the filler. Although the wrapper constitutes but one fifteenth to one twentieth of the cigar, its influence upon the quality of the cigar is very great, apparently on account of its being plain to the view and of its possible effect upon the combustion process. Certain it is that the flavor and aroma of a wrapper is always considered in blending tobacco for high grade cigars. Obviously, therefore, the most important of the three materials is the wrapper. It is the real seller of the cigar. Instinctively, the smoker is first attracted by the outward appearance of the cigar just, as a prospective buyer of a piece of furniture is first attracted by a beautiful finish. In view of this fact and because of the manifold requirements of a standard wrapper, the industry is classified as a specialized phase of the great tobacco industry.

Science has been called in to aid this industry with remarkable results. Experiment stations wholly devoted to research work in tobacco, particularly in wrapper production, have been established. The tobacco experiment station in Medan, Sumatra, the famous island home of the world's best wrapper, is a very good example of the way science is aiding this great industry. The activities of this station are considered to surpass the activities of any similar station elsewhere.

Sources of wrapper.—There are three principal countries supplying the wrapper tobacco of the world, namely:

(*1*) *Sumatra.*—The tobacco trade has accepted the Sumatra wrapper as unquestionably the best and, therefore, the standard of excellence for cigar wrappers. The Sumatra wrapper is produced in the island bearing the same name, a Dutch possession in the East Indies. The United States alone imports about 5,000,000 pounds of Sumatra wrapper yearly. Germany, France, England, the Netherlands, and other European countries are heavy purchasers of Sumatra wrapper tobacco. The Sumatra wrapper is not imported directly from the island of Sumatra but through inscription in Amsterdam and Rotterdam, Holland. Because of the peculiarly adapted soil and the climate of the island, Sumatra tobacco is naturally of a wrapper nature, a character which has been further improved by breeding and selection and by scientific methods of culture. A factor which can not be overlooked is the plentifulness of coolie labor which means that the work can be done entirely by hand. The abundance of land makes intensive agriculture unnecessary. It is claimed that in Sumatra a tobacco field is used only once in seven to twelve years. That is, after it has been cultivated for one season, it is allowed to become nature's garden and is not cleared or used again until seven or twelve years afterwards.

The Sumatra wrapper is an almost tasteless, neutral tobacco as to flavor and, therefore, has an affinity to all kinds of cigar filler. Its further favorable characteristics are its glossy appearance, its highly uniform color, and its remarkable elasticity and fineness. American manufacturers have persisted in the use of Sumarta wrapper in spite of the exhorbitant duty paid for it upon entrance into the United States. The fact that Sumatra never produces filler tobacco and, therefore, does not supply wrapper to any local factories, compels her to produce a quality of wrapper that is universally accepted by importing countries. The outcome is, the creation of the famous Sumatra wrapper which has an affinity to practically all filler tobacco produced in the tobacco producing countries.

(2) *Cuba.*—"Havana" seems to be better known than the term "Cuban" as applied to all tobacco grown on the island of Cuba. Havana as a cigar tobacco, that is, including filler and binder, is considered the finest in the world. Strictly speaking, however, with respect to wrapper, it has not the reputation of the Sumatra. In former years, the Cuban wrapper was produced in the open, but because of the demand for a finer grade the use of the shelter tent was introduced. To-day, the Cuban wrapper is produced almost entirely under shade. Partidos district is claimed to be the most naturally adapted region in Cuba for the production of wrapper. The importation by the United States of Cuban leaf tobacco amounts to about 16,000,000 pounds annually, a great portion of which must be wrapper tobacco.

(3) *United States.*—The Connecticut Valley and the districts of Florida and Georgia are the principal wrapper tobacco regions of the United States. The former raises from 70 to 80 per cent of all the wrapper tobacco produced; Georgia and Florida furnish the rest. Practically all the wrapper tobacco produced in the United States is grown under partial shade. The Connecticut Valley broadleaf and the Havana seedleaf are the only varieties grown for wrapper purposes. The former has a broad silky and very elastic leaf, while the latter, though smaller, is exceedingly thin. The annual production of the United States is from 30,000,000 to 40,000,000 pounds. There was a time when the Sumatra was tried in Florida, but ultimately the growing of this variety was given up because of its inferior characteristics when grown outside its home country. The Florida-grown Sumatra, however, is now cultured in the open as sun-Sumatra strictly for filler purposes.

Miscellaneous sources of wrapper.—Porto Rico has become quite an important wrapper producer lately owing to the introduction of modern methods of culture, specially the use of shelter tents. The United States imports from Porto Rico about 30,000 bales of leaf tobacco annually and no doubt a portion of this is wrapper tobacco. In tropical and semi-tropical countries like Mexico, and the Philippine Islands an appreciable amount of wrapper is obtained from the lower leaves which are thin and glossy due to the shade given by the upper leaves. The supply, however, does not meet the demands of the manu-

facturers with the result that additional wrapper must be imported from the outside, mainly from the United States and Sumatra through Holland.

The United States does not import leaf tobacco for wrapper from the Philippine Islands, but in her importation of cigars and cheroots the products of the Philippine Islands form a large proportion. Philippine cigars, excepting a very limited proportion, are wrapped with native wrappers. High quality Philippine cigars are either wrapped with imported Sumatra or with United States wrapper. Recently, however, the Filipino tobacco growers embarked into the production of purely wrapper tobacco by the use of shelter tents, and in the course of a few years, the country may not only become self-sufficient in her wrapper needs, but may eventually become a wrapper-tobacco exporting country. The existence of ideal soil and climatic conditions coupled with the availableness of suitable varieties for the production of wrapper tobacco in open culture, under more or less humid conditions and in shade culture under more or less droughty conditions, promise a future with bright prospects for the Philippines.

II. CLIMATIC AND SOIL REQUIREMENTS

Climatic requirements.—The production of wrapper tobacco is highly localized. The characteristics which distinguish one type of tobacco from another are primarily the results of a combination of climatic and soil conditions, together with the method of curing and the variety grown in this or in that locality. The various kinds of tobacco demanded by consumers also have a very great effect upon the production of specialized products. These demands are successfully met by the selection of the right locality and the use of persistently progressive methods. Tobacco is one of the most profitable cash crops; for this reason practically every agricultural country has tried to raise it. But while everyone has been and is still trying to employ the same cultural and curing methods and using possibly the same seed or variety, yet the final product is in a general case only typical for this or for that locality where it is produced.

Climate is a great limiting factor. As far as records show, the Sumatra variety has been grown in Florida and in the Philippine Islands for a considerable number of years, but the crop

thus produced is not exactly identical to that obtained in Sumatra, its home country. There seem to be no other more important factor in causing this condition than the difference of climate existing in Sumatra, Florida, and the Philippines, coupled, of course, with variations in soil.

TABLE 1.—*Climatic conditions of Cuba and U. S. (Connecticut Valley)*

(*a*) MEAN MAXIMUM TEMPERATURE IN FAHRENHEIT

Connecticut valley		Cuba	
April	56.70	October	82.40
May	69.90	November	79.90
June	78.00	December	77.00
July	82.10	January	77.40
August	78.90	February	79.00
September	71.23	March	80.80

(*b*) MEAN MINIMUM TEMPERATURE IN FAHRENHEIT

April	34.40	October	74.10
May	46.50	November	70.70
June	55.90	December	68.00
July	60.50	January	66.90
August	58.70	February	68.00
September	50.78	March	67.40

(*c*) AVERAGE MEAN MONTHLY RAINFALL IN INCHES

April	3.33	October	6.57
May	3.78	November	1.94
June	3.79	December	2.27
July	4.70	January	2.75
August	4.86	February	2.06
September	3.85	March	1.21

(*d*) MEAN RELATIVE HUMIDITY IN PERCENTAGE

April	63.00	October	76.00
May	66.00	November	76.00
June	70.00	December	74.60
July	70.00	January	74.44
August	74.00	February	73.60
September	74.33	March	69.30

(*e*) AVERAGE MONTHLY RAINY DAYS

April	8	October	15
May	11	November	10
June	9	December	9
July	10	January	8
August	9	February	6
September	8	March	5

TABLE 2.—*Rainfall types in the Philippines compared with Sumatra in millimeters*

	Echague, Isabela	San Fernando, La Union	Davao, Davao	Tacloban, Leyte	Medam, Sumatra
January	66.1	6	118	355.9	196.6
February	38.3	8.2	134.9	220.7	83.8
March	51.6	9.1	161.3	155.7	150.0
April	69	17	162.8	132.9	115.2
May	155.4	191.6	256.6	155.4	213.2
June	99.8	304.7	258.6	199.9	157.0
July	202	621.8	190.1	173.7	126.8
August	208.6	664.4	193	136.8	178.2
September	205.5	451.8	198	150.3	250.6
October	215.9	172.5	255.8	202.2	257.8
November	223.2	42.5	166.5	275.1	302.6
December	157.6	8.6	194.7	350.7	181.0
Annual	1,683.0	2,498.2	2,290.3	2,509.3	2,422.8

Tables 1 and 2 show that Sumatra has almost a uniform precipitation while in the Connecticut Valley, in Cuba, and in the Philippine Islands the weather conditions are quite variable, considering the climatic figures of the last three countries, one might too readily concludee that the differences are not so significant. The fact is, however, that differences exist, and the variability, no matter how slight, is enough to account for the difference in the quality of crop produced in the various districts. Whitney made an irrefutable statement when he said that "the plants are most sensitive to meteorological conditions than are our instruments." Another important factor that must also be considered is the fact that the various field operations and the seasons vary. The Connecticut Valley tobacco season lasts from April to September, while in Cuba, Sumatra, and the Philippine Islands the season lasts from August to June.

TABLE 3.—*Optimum field operations in the principal wrapper-tobacco producing countries*

Countries	Sowing of seed	Transplanting	Harvesting
Connecticut Valley, U. S. A.	April	May–June	August–September.
Sumatra	August–September	October–December	January–June.
Cuba	August–September	October–November	January–April.
Philippine Islands	September–October	November–January	February–May.

It is the consensus of opinion that tobacco is grown to greater advantage in tropical and semi-tropical countries than in tem-

perate regions. One might well ask why the Connecticut Valley, a decidedly temperate region, produces some of the best tobacco in the world. The answer to this inquiry cannot be sought in climatic conditions alone. It is certain, however, that the persistent efforts of research in breeding, acclimatization, selection, and adaptation, coupled with improved and systematic methods of culture and curing, in the United States resulted in the development of tobacco varieties that are among the best in the world. Notwithstanding the prominence of the United States, however, as a tobacco-producing country, the most prominent cigar tobacco-producing regions are Cuba, Sumatra, Brazil, Java, Porto Rico, and the Philippine Islands—practically all tropical countries. Excepting the countries of Sumatra and Java, the tendency of wrapper tobacco growers is to grow wrapper under shelter tents or lath shade. This method of producing wrapper tobacco, while it is seemingly laborious and expensive, is now considered the most practical and economical method of growing a wrapper crop of good quality. Sumatra is favored with ideal climatic and soil conditions which permit her to grow her wrapper tobacco under open culture, a natural process which is not to be found in other tobacco countries. It is claimed that in Sumatra there is an almost even distribution of rainfall throughout the year, and the prevailing practice of using a tobacco ground once in every seven to twelve years insures the production of fine wrapper under open culture.

Inasmuch, however, as certain Philippine regions possess climatic conditions virtually identical with those of Sumatra (see Table 2), the prospects of raising wrapper in this country in open cultures, are quite great.

Soils and fertilizers.—No crop is more responsive to slight changes in soil than tobacco. In the United States as elsewhere, there are only few localities where more than one kind of tobacco is grown. Even in these localities the resultant crop is generally used for the manufacture of only one kind of tobacco product. A good example is the Florida district where filler, binder, and wrapper types are produced, but these products are utilized only for the manufacture of cigars. Different varieties have been bred to meet specific requirements, but when these are transferred to a new environment, they immediately lose some of their characteristics, and consequently, some of their value. It is for this reason that it is not safe to jump at the

conclusion that a standard variety in one place will behave similarly in another locality. The ideal soil for wrapper tobacco ranges from sandy loam to fine sandy loam, which is rich, deep, porous, well drained, and easily worked. Heavy soils, specially clay soils, are not suitable for wrapper-tobacco growing as they are likely to produce coarse and heavy crops. A good supply of organic matter must always be present in wrapper tobacco soils. Organic matter contains all the necessary plant foods in different stages of availability from the freshly turned over dead vegetative matter to the completely decayed and dissolved complex humic food.

To give an idea as to the physical composition of soils suitable for the production of wrapper tobacco, the analyses of representative soils of different wrapper producing countries are given in Table 4.

TABLE 4.—*Mechanical analyses of subsoils of leading wrapper tobacco districts of the world*

Number of samples	District	Moisture in aired sample	Organic matter	Gravel	Coarse sand	Medium sand
		Per cent		*2–1 mm.*	*1–0.5 mm.*	*0.5–0.25 mm.*
29	Florida Peninsula	.62	1.73	.26	2.60	18.94
8	Sumatra	7.48	15.11	1.41	4.39	9.95
6	Cuba (Vuelta Abajo)	.74	3.80	4.06	4.62	8.28
9	Connecticut Valley	.76	2.53	1.03	3.26	9.92

Number of samples	District	Fine sand	Very fine sand	Silt	Fine silt	Clay
29	Florida Peninsula	51.53	18.95	1.33	.59	2.21
8	Sumatra	16.15	17.17	19.11	4.35	5.00
6	Cuba (Vuelta Abajo)	21.67	43.09	6.53	1.82	5.69
9	Connecticut Valley	22.62	45.47	10.41	1.36	2.32

In principle the chemical composition of soils is not important in wrapper production. In the first place, the cigar wrapper is not what is actually tasted by the smoker since in proportion to the entire cigar it is very insignificant. The main objective in the growing of cigar wrapper, is to insure the rapid and uninterrupted growth of the plants and thereby prevent unnecessary thickening of the tissues, since the most desired characteristic of cigar wrapper leaves is their fine texture almost akin to silkiness. And this can only be effected through

an appropriate soil texture. Consequently, the subject of physical condition of the soil, is discussed at length in this paper.

A soil of more than normal fertility is easy to determine by merely observing the excellent growth of the prevailing vegetation. Such soils are obviously suitable for wrapper tobacco, provided, they possess the right physical texture as already described.

In Sumatra and in the Philippine Islands the application of fertilizer does not present so much of a problem. Owing to the abundance of land, the tobacco growers of Sumatra, as has been stated, can afford to use the same tract of land at wide intervals of time. This practice of fallowing the land allows the ground to become virgin once more before it is used for further tobacco growing. In the Philippines, the cigar tobacco districts are located along river banks that are inundated almost every year, and although the same parcel is used annually, the overflow of the rivers always leaves considerable deposits of fine rich soil and decayed vegetation which make the land sufficiently fertile. In the Ilocos provinces, particularly in La Union Province, the small valleys in the mountain regions which are rich in humus, due to the wash deposits from the hills, are the best regions for growing wrapper tobacco. The case is different in Cuba, the United States, and elsewhere. The limited areas suitable for wrapper culture and the large demand for wrapper leaf make it imperative that all available lands be planted every year. The question then arises as to what must be done to these lands in order to keep their productivity at a maximum. In the first place, the application of commercial fertilizer and animal manure must be practiced; secondly, cover cropping and green manuring must be resorted to. In fact, poor ground must be fertilized before the tobacco crop is set in, planted to a quick cover crop after the tobacco is harvested, then plowed under before it reaches maturity. In the United States no crop is so heavily fertilized as tobacco, followed by cover cropping and green manuring. This practice prevails especially in the Connecticut Valley because it is believed there that the application of commercial fertilizer leaves a great deal of residue which will be leached out during the fall rain. The cover crop serves to catch the nitrification products from these residues. The cover crop is later on plowed under as green

manure. Cowpeas, soybeans, vetch, rye, timothy, and other cover crops were found to be among the best green manures for tobacco fields.

The question of fertilizer application is not an easy one to solve. Cases have been known where, by chemical analysis of the soil, the necessary plant foods have been found abundant enough and yet the land has not produced a decent crop. The importance of the desired physical condition of the soil enters into consideration here. Fertilizers only give results when the soil is of the proper texture and contains sufficient moisture to render the plant food available to the plants. To obtain these conditions the soil grains must be thoroughly mixed, hence the value of thorough cultivation and tillage. The question of whether complete fertilizers or simply the elements apparently lacking need be applied, is for the growers to decide. Owing to the high cost of fertilizers, there is a tendency on the part of the growers to use simpler fertilizers. The determination of the deficient plant food then becomes necessary. The deficiency can be determined by classifying the land as to origin and farming adaptation, analyzing it chemically by groups, and testing it by actual field experiment. The purpose of fertilizer application is to produce a rich land, not rich spot, so that the proper method of applying fertilizer is to broadcast and harrow it in. It can however, be applied in the rows and covered during transplanting. The application of coarse manure in the fall or winter, followed either by late fall or early spring plowing, is recommended by the Wisconsin Experiment Station. Commercial fertilizers should be applied in the spring after the land has been plowed and shortly before transplanting. Fertilizers should not be applied unless the land is in good tilth, as otherwise the plants will not be in the best environment to use them. Furthermore, fertilizers, when applied on soil of poor tilth, are readily leached out. As a general guide in the application of commercial fertilizers for tobacco lands the following are recommended.

1. Ammonia, 4 to 5 per cent; phosphoric acid, 2 to 4 per cent; potash, 8 to 9 per cent.

2. Ammonia, 2 to 4 per cent; phosphoric acid, 8 to 10 per cent; potash, 2 to 7 per cent.

TABLE 5.—*Showing the most common sources of the three basic elements, their average composition and value which may be used for tobacco*

Fertilizer	Per cent nitrogen	Per cent phosphoric acid	Per cent potash	Average application per acre	Average value per ton
SUPPLYING NITROGEN					
Nitrate of soda	16	0	0	200 lbs.	$60.00
Sulphate of ammonia	20	0	0	175 lbs.	75.00
Tankage (meat and bone)	5	11	0	400 lbs.	31.00
Dried blood	12	4	0	300 lbs.	60.00
Cottonseed meal	7	2	2	500 lbs.	32.00
Fish	6	8	0	400 lbs.	35.00
SUPPLYING PHOSPHORIC ACID					
Acid phosphate	0	15	0	600 lbs.	16.00
Ground bone	3	24	0	300 lbs.	35.00
Dissolved bone	2	16	0	500 lbs.	25.00
SUPPLYING POTASH					
Sulphate of potash	0	0	50	200 lbs.	55.00
Sulphate of potash and magnesia	0	0	28	400 lbs.	30.00
Wood ash (unleached)	0	0	6	1 ton.	8.00
ANIMAL MANURES					
Barnyard manure	0.5	0.25	0.5	10 tons	2.00
Sheep manure	1.0	0.5	0.5	6 tons	3.00
Chicken manure	1.5	1.0	0.75	4 tons	5.00

Tobacco farmers should avoid the application of fertilizers with appreciable amounts of chlorine, and sulphuric and other free acids, as these elements markedly affect the burning quality of the leaf. Chlorine is contained in common salt, muriate of potash, kainit, and generally in the lower and cheaper forms of potash salts. The use of these fertilizers should, therefore, be avoided. Manures must not be allowed to lie long in the open because nitrogen in the form of ammonia escapes into the air while soluble plant foods such as potash and ammonia are washed out by rain. These materials should, therefore, be kept and seasoned out in farm barns before they are applied in the fields.

Farmers should always refer their fertilizer problems to the nearest experiment station to avoid grave mistakes and possibly useless expenditures. The planter must experiment with fertilizers himself.

III

CHOICE OF VARIETY

There are as many varieties of wrapper tobacco as there are wrapper tobacco regions. A good wrapper variety in one place may not be a good variety in another district and vice versa. Every wrapper-tobacco district should, therefore, strive to develop a standard variety for itself which is ideal for the locality. Among the most important wrapper varieties which are extensively grown in the four wrapper-tobacco districts of the world are:

1. UNITED STATES

Connecticut Valley broadleaf.—The broad-leaf varieties of the United States produce long pointed drooping leaves, averaging in length a little over twice the breadth with a leaf area of about 9 square decimeters. The number of leaves per plant ranges from 16 to 23 and averages from 19 to 20. The average height of plants is about 150 centimeters. Under shade culture the yield per acre is from 1,100 to 1,300 pounds, and under open culture, from 1,600 to 1,900 pounds per acre. This variety sells at slightly more per pound than the Havana. It is grown in the open in the Connecticut Valley for filler and binder, but is also extensively grown under shed tents for wrapper production.

Havana seedleaf.—This variety produces medium-sized leaves, standing nearly erect though drooping slightly at the tip. The average length of the leaf is a little more than twice its breadth. The number of leaves per plant ranges from 16 to 25 with an average of from 19 to 20. The average height of the plants is about the same as the broadleaf varieties. This variety is well known as a wrapper tobacco grown extensively under shelter tents and lath sheds. It is also grown under open culture for filler and binder. The average yield per acre is from 1,400 to 1,700 pounds under open culture, and from 1,000 to 1,100 pounds per acre under shade culture.

Sun-Sumatra.—This is an open field type grown for filler and binder in Florida district. A small quantity of wrapper is also produced from it. This variety was introduced into the United States from Sumatra.

2. SUMATRA

Sumatra.—This variety produces almost round pointed erect leaves a little more than half as broad as they are long, with an average leaf area of about 5 square decimeters. The upper or top leaves are generally narrow and pointed. The average number of leaves per plant ranges from 20 to 32, and the average height of plants is about 210 centimeters. This variety produces an exceedingly high grade of wrapper which is at present considered the standard for wrapper tobacco. The yield per hectare is about 1,500 pounds.

3. CUBA

Cuban Havana.—This variety is the same as the United States Havana and the Texas Cuban varieties. It has rounded almost erect leaves. The number of leaves per plant ranges from 16 to 25. The leaves are bigger than those of Sumatra. Havana is a very popular variety in Cuba, grown both for filler under open culture and for wrapper under shade culture. Under open culture, Cuban Havana produces as high as 2,000 pounds per acre and as high as 1,400 pounds per acre under shade culture.

4. PHILIPPINE ISLANDS

Simmaba.—A dual purpose variety originally found in La Union Province, similar to the standard "Marogui" variety of the Cagayan Valley. It is grown mostly in the mountain regions. In shape the leaves resemble the United States broadleaf varieties, but are even larger. Plants produce from 28 to 36 leaves, with standard measurements of 104 centimeters in length and 68 centimeters in width. The height of the plants ranges from 200 to 245 centimeters. Grown in the open, it produces as much as 1,500 kilos, and under shade culture 1,000 kilos per hectare. It can well resist the wilt disease. So far it is the best native variety for shade culture under droughty conditions as prevailing in La Union Province. The leaves can be easily cured to a light color. This variety has been improved by selection by the Bureau of Plant Industry.

Vizcaya.—This variety produces as big as but narrower leaves than the Simmaba. Its leaves, however, possess a good curing quality, turning light quite readily. The leaf length is generally more than double the width, and the plant grows exceedingly tall, reaching a height of from 220 to 250 centimeters. The average number of leaves varies from 28 to 42 leaves, including

the tops. This variety was originally found in Cagayan Valley, where it is now grown quite extensively after six years of rigid selection at the Ilagan Tobacco Experiment Station. It is preferable for shade culture under somewhat moist or less droughty conditions as prevailing in southern Laguna Province. It is also a dual purpose variety.

Philippine Baker's Sumatra.—The plants have the same development as the genuine Sumatra with an average height of 210 centimeters. The average number of leaves is 30, with average measurements of 42 centimeters in length and 27 centimeters in width. When grown in the open it gives an average of 1,008 kilos per hectare, 324 kilos of which are marketable wrapper. Under shade culture, it produces 658 kilos per hectare, 400 kilos of which are marketable wrapper. This is a small to medium-leaved variety. When grown in the open and planted quite late, it cures readily to yellow. The variety is of Sumatra origin, introduced into the Philippines through the efforts of the late Dean Charles Fuller Baker of the College of Agriculture, University of the Philippines.

Ilagan Sumatra.—The Philippine Baker Sumatra is a perfectly satisfactory cigar wrapper variety, but, principally because of the prejudice of the Filipino tobacco grower against small and medium leaved varieties, intensive pure line selection was started during the 1924–1925 season at the Ilagan Tobacco Station, to develop a strain which if possible will produce bigger and rounder wrapper leaves. At this time the mean breadth index of the Philippine Baker Sumatra was 52.78 per cent. During the 1928–1929 season a strain with virtually 70 per cent breadth index was developed. This strain, differing from the original variety in at least two important characters and being true to type, naturally is called a distinct standard variety of the cigar wrapper type. The variety has been called Ilagan Sumatra to commemorate the town of its origin. This variety differs principally from the Philippine Baker Sumatra by its wider and larger leaves. The Ilagan Sumatra has ovate-orbicular leaves (Plate 29) while the Philippine Baker Sumatra has ovate leaves.

IV. SEED BED AND FIELD OPERATIONS

Preparation of seedbeds.—The successful production of wrapper tobacco depends in a large measure upon the farmer's ability to rear vigorous, uniform, and healthy seedlings. Any land that

is good for growing tobacco may be utilized for seed bed purposes. It is the general practice, however, to use higher ground for seed beds to avoid the possible danger of floods and stagnant water. Sloping virgin lands, if available, are the best locations for seed beds as the difficulties of laying deep drainage canals and the application of fertilizers are thereby avoided. In the tropics, the beds are prepared one meter by ten meters. This is a convenient size for the many operations involved—constructing, weeding, placing covers, watering, etc. The earth is raised about a foot above the general level in bed form and the sides of the beds are supported by bamboo which may be substituted by wood. A patch about a half a meter wide, which serves also as drainage, separates the plots. Each bed is thoroughly worked to a depth of more than one foot. All roots, stumps, and other waste materials are raked out and the soil is thoroughly pulverized. This done, the beds are sterilized. There are various methods of seed bed sterilization, namely:

(1) *Open-fire.*—In the tropics, where dead vegetation is abundant, the seed plots are covered with dry grasses, twigs, and bushes and are then burned. The heat is forced through the beds, killing suckers, roots, and seeds of weeds and fungus and bacterial organisms.

(2) *Roasting.*—Heating or roasting the soil in a suitable pan is a modification of the open-fire method. The soil of the beds is shoveled into pans and heated to a certain degree in order to kill all fungi and bacterial organisms. Then it is returned to the beds.

(3) *Hot water treatment.*—The beds are treated with boiling water to kill all weed seeds, roots, suckers, fungi, and bacterial organisms.

(4) *Formaldehyde treatment.*—A solution of formaldehyde (one part formalin to 100 parts water) is sprinkled on the beds at a ratio of one gallon per square foot. The beds are then covered with burlap or sash to hold in the fumes. After a week they are ready for sowing. The common objection to this method is the costliness of the formalin.

(5) *Steam sterilization.*—Steam current from a boiler is passed through the soil several times. This method was devised by the U. S. Department of Agriculture, Bureau of Plant Industry and is now being extensively used in the Connecticut Valley. The outfit necessary for the operation consists of a boiler, some lengths of good pressure hose, and two or more pans made of galvanized iron or wood.

The use of any one of these methods depends upon its suitability to the place. In the Philippines, for instance, tobacco farmers do not sterilize their seed beds but simply select virgin places for them.

The importance of the use of fertilizers on old land for seed beds is best summed up by Olson in Bulletin 130 of the Pensylvannia Agricultural Experiment Station as follows:

> Tobacco plants are forced to spread their roots widely when growing in an insufficiently fertilized bed. This causes slow growth above the ground, and when the plants are pulled the straggling spreading roots are damaged, a condition which later interferes with the growth in the field. It is, therefore, advisable to fertilize the beds well for the reason that the plants will not only grow faster but the roots will not spread out in search of food; they obtain it in a small area, and consequently grow in a close, compact branch which makes it possible to pull the plants with small loss and less injury to the rootlets.

The application of fertilizer, however, requires discretion. While mineral fertilizers can and should be applied after sterilization, compost and animal manure should be applied before sterilization as these fertilizer materials may likely contain destructive organisms that will damage the seedlings. In the U. S. Department of Agriculture Farmer's Bulletin 571, Dr. Garner suggests the following method of fertilizing tobacco seedbeds:

> In the fall 40 pounds of lime and 200 pounds of stable manure to 100 square feet of seedbed are plowed under. In the spring about two weeks before sowing the seeds, additional fertilizer should be applied per 100 square feet of bed area consisting of 20 pounds of cotton seed meal or castor pomace, 1 pound of acid phosphate, and one half pound of carbonate or sulphate of potash. These materials are thoroughly spaded into the soil to a depth of 4 to 5 inches and the surface of the beds brought to a fine tilth.

In the Philippines, in La Union Province, powdered and well decomposed chicken manure is used for dressing tobacco seedbeds with excellent success. The manure is spread over after the seed is sowed.

Once the beds are formed, sterilized, and fertilized, a suitable shelter is constructed over every bed to protect the beds from heavy rain and strong sunlight. The shelter is raised about a meter in front and seventy centimeters at the rear to facilitate moving about during watering, weeding, and worming. Sheds on seed beds are important to reduce evaporation, so that more moisture remains in the soil, hastening germination, and at the same time to protect the seedlings from heavy rain. In the Tropics palm and grass leaves are used for seed bed covers. In

the United States the seed beds are similarly constructed although the width is even more than 6 feet and the area not less than 180 square feet. In the northern districts like Connecticut, substantial frames are built over seed beds to hold the cloth or glass covers. In some cases, steam pipes are laid in the beds for heating the soil in case of emergency.

Sowing of seeds.—Experience is the safest guide with reference to the right time for sowing. In the temperate countries the best time for sowing the beds is from the middle of March to the middle of April. This time is computed principally on the ground that it takes from six to eight weeks to produce transplanting seedlings in cold beds and from four to six weeks in hot beds. If cloth cover is used instead of glass, at least two more weeks must pass before the seedlings are ready for transplanting. If sowing were done earlier, resulting in earlier planting, the dangers of late frost might be encountered. The following dates from the records of the U. S. Weather Bureau show the average actual time of the last killing frost in the spring and the earliest killing frost in the fall in the wrapper tobacco districts of the United States.

TABLE 6.—*Showing the average time of the last killing frost in the spring and the earliest killing frost in the fall in the United States.*

State and locality	Spring		Fall
	Average	Last	Earliest
Connecticut, New Haven	May 30	May 30	September 15.
Massachusetts, Boston	---------	May 17	September 30.
Florida, Pensacola	May 7	Apr. 6	November 12.

In the Tropics, the chief problem of the growers lies in the rain which may fall too late, just like the frost. Late rain means late transplanting. The only effective way by which planters can overcome this uncertainty of the weather is the sowing of seed beds three times more than necessary at intervals of 15 to 20 days, beginning the middle of August. Seeds must be sown sparsely to avoid thick growth or overcrowding of seedlings as this results in the production of weak seedlings. Thick sowing also predisposes to damping-off disease which is very common in seed beds.

In Sumatra one gram of seed mixed with sifted carrier, such as sterilized dust or ash, is sown into every square meter of seed bed, or one teaspoonful of seed for every 100 square feet of seedbed. A bed of 10 square meters usually yields not less than 2,000 good seedlings. This method of sowing in Sumatra is similar to that employed in the Philippines. In the United States, Dr. Garner of the Bureau of Plant Industry suggests sowing at the rate of an even teaspoonful of seed to every 100 square feet of bed area and to secure an even distribution, the seed should be mixed evenly with wood ash. The beds are packed down after sowing either with a roller or a plank and then covered with cloth, glass, or palm leaves. The practice of sprouting or forcing the seeds to germinate before sowing in order to gain an earlier start is not a good one. It is more advantageous for the seed to germinate at the temperature and on the place where it will have to spend its early growth than to hasten germination in an entirely different environment and to transfer it later to the seed plots.

Care of seedlings.—After the seeds are sown, they should be watered to keep the soil moist. Too much watering is to be avoided, however, as it causes the soil to harden upon drying. As soon as the seeds have germinated, the beds should be sprinkled regularly every day, but sparingly. When the weather is too windy, watering the beds twice a day becomes very necessary, as evaporation is rapid during windy days and the beds dry up more quickly. The beds should be uncovered occasionally to expose the seedlings to the morning sun in order to harden them. This, too, is necessary to avoid fungus diseases. In the Philippines, it is the practice to remove permanently the sheds of the seed plots 20 to 30 days after sowing, allowing the seedlings to grow in the open as soon as they are strong and big enough to resist strong rain and sunshine. In this way, the seedlings become accustomed to growing under natural field conditions, and, when transplanted in the field, recover very quickly. The beds should be weeded regularly as soon as the seedlings are big enough not to be disturbed or pulled out with the weeds. If worms appear in the seed bed in sufficient abundance to be dangerous, the seedlings should be dusted with calcium arsenate mixed with wood ash to the proportion of one part calcium arsenate to 20 parts wood ash or other suitable carrier. If a

solution is used instead of the powder, the calcium arsenate solution shouuld be only of one to two per cent concentration. In either case, the seedlings should be dusted or sprayed only sparingly as overapplication of the arsenical may burn the leaves if not altogether kill the plants, especially if the concentration is quite strong. The Flit guns is a handy and cheap sprayer if the use of solution is resorted to. If a hand dusting machine is not available, an ordinary cheese cloth bag will be a good substitute for dusting purposes. The bag is filled with the powder mixture and shaken over the seedlings. This method of dusting was found very practical and quite convenient in the Cagayan Valley.

Preparation of the field.—The field should be plowed at least twice to a depth of about a foot and then thoroughly harrowed to enable the roots of the seedlings to extend well down. Thorough stirring of the soil also conserves the soil moisture, and, at the same time, distributes the fertilizer uniformly. With a well-distributed food supply and sufficient moisture in the soil the growth of the plants will be rapid and normal—conditions which are essential in securing leaves of the finest texture. Slow growth due to improper preparation of the field results in the slow development of the plants, at the same time risking the exposure of the plants to early drought and, what is worse, to the attack of insect pests for a much longer period of time. It may be of interest to consider in this connection the fact that in the tropics every phase of the work in the field from the clearing of the ground to the curing of the crop is still done by man and animal power, while in the United States most field operations are performed by machinery.

Transplanting.—Seedlings should be ready for transplanting from 45 to 60 days after sowing, or when they are about 5 or 6 inches high. Seedlings fit for transplanting must be sound, healthy, vigorous, and uniform in size. Great care must be exercised in pulling the seedlings from the beds, as the slightest injury to the stems and roots retard the growth of the plants. If there has been no recent rain to soften the ground sufficiently to make it easy to pull the seedlings, the necessary amount of water must be sprinkled on it before attempting to pull them out. The best time to transplant is after three o'clock in the afternoon. On cloudy days, however, transplanting can go on

throughout the day. If the weather is too hot during transplanting, it is necessary that the newly set plants be protected from the sun by covering them for at least three days with banana petioles or other suitable materials. Once transplanting has begun, it should go on uninterruptedly until the whole field is planted. This is very desirable for uniformity of the stand. When there is uniform stand, priming is facilitated and a very uniform crop is obtained. The leaves are harvested all at the same time and at almost the same maturity. The period of transplanting wrapper tobacco in the different wrapper tobacco districts is given in Table 3, together with other field operations. Under open culture, the plants should be set nearer in order to protect the majority of the leaves, especially the lower ones, from a good deal of light. The leaves will intershade intimately and under such conditions will become fine, thin, and elastic. The big varieties, such as Broadleaf, Simmaba, Viscaya, and Havana seedleaf, when grown under open culture, should be planted from 80 to 90 centimeters between the rows and from 60 to 70 centimeters between the plants in the row. The Sumatra varieties, because of their small size, can be planted at 80 centimeters between the rows and 40 to 50 centimeters between the plants in the row, either open-grown or shade-grown. Under shade culture opinions on distances of planting vary. Some planters prefer to grow their tobacco at closer distances in order to accommodate more plants per unit area of shaded ground, while others plant their tobacco at greater distances in order to obtain big but fine, thin, and elastic leaves. What distances of planting should be followed depends upon the variety to be planted and the fertility of the soil. In rich lands, spacing can be closer even for the big varieties under shade culture. The plants will develop big leaves just the same, but under open culture it is necessary that the leaves of the plants in the rows interlap to produce a fine-textured wrapper crop, hence the necessity of planting closer between the plants. In the Philippines, the big varieties under shade culture are spaced 80 by 70 centimeters apart, the Sumatra varieties at 80 by 50 centimeters, in open as well as shade culture. In Sumatra, where shading is never resorted to because of the favorable natural conditions, the "alternate close and distant row"

method of planting is practiced. That is, the plants are set in a triangular way (quincunx effect) as in the following diagram:

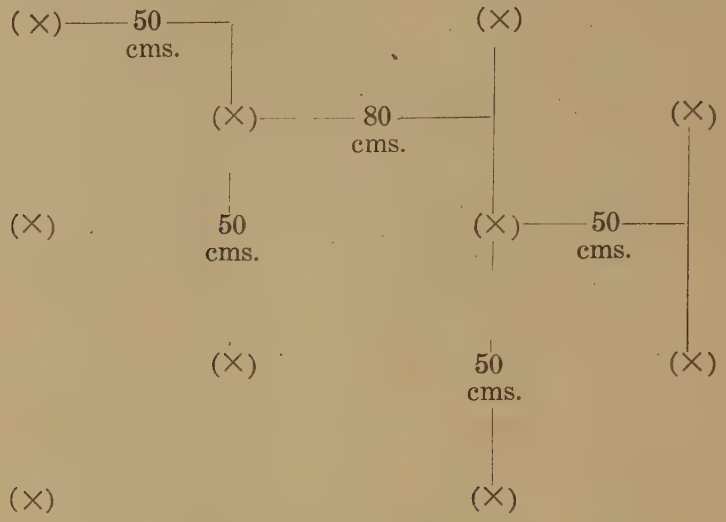

DIAGRAM 1.—Showing Sumatra method of setting cut plants.

Setting is done either by hand or by machinery. Hand setting is, of course, very simple. The rows and the points where the plants are to be set are marked by sticks or pegs. With the dibble, a hole 4 to 6 inches deep is prepared into which the plant is placed perpendicularly up to its neck. The soil is then packed around the plant to give the root a firm hold and at the same time to brace the stem. The newly set plant is then hand-watered and the wet soil covered with dry soil to prevent rapid evaporation and baking. This covering of the wet soil around the plant with dry soil is very important because, if the soil is allowed to bake, it shrinks and subsequently cracks, so that a considerable amount of moisture escapes and at the same time the root system of the plants are strained. The tobacco transplanting machine is a labor-saving device and is now extensively used in the United States. It has its advantages in that the setting of the plants in proper distances, transplanting, packing the soil around the plants, and watering are all done automatically. An ordinary transplanting machine is drawn by two horses and carries a driver and two planters who manipulate all the transplanting operations, each man setting alternate rows. A V-shaped plow makes an opening into which the plant is set and is held in place until the soil around it is

packed by means of a pair of paddle-shaped blades which follow the plow. By means of a special gearing on the wheels, definite quantities of water are released at uniform distances. With the transplanting machine the human labor is dispensed with, even in planting large areas. Replanting should follow after a week, as it never happens that all plants set initially survive. Bigger seedlings should be used in replanting, and there should be enough of these seedlings on hand for the purpose.

Cultivation.—In two or three weeks after transplanting the plants should have fully recovered and cultivation can begin. Cultivation is the process of stirring the ground in order to keep the soil from hardening or becoming compact. It enables the roots to extend freely and also eradicates weeds and conserves soil moisture. Cultivation is done either by plowing the space between the rows or by hoeing, to form ridges on the rows of plants. The tooth-cultivator and the tobacco hoer implements are both great labor-saving devices. Unless weather conditions interfere, the fields should be cultivated every ten days. Three cultivations done thoroughly are sufficient, as by that time the plants will be too big for further cultivation, if growth has been rapid. In Sumatra, where the "alternate close and distant row" method of transplanting is practiced, cultivation is done by banking. By banking is meant the construction of deep drainage canals every two or more rows of tobacco, the soil dug therefrom being deposited on plant beds formed therein. Eventually the plantation is divided into beds gradually elevated, as the excavation of the canals continues. In some instances the canals are almost a meter deep. The Sumatra method of growing and cultivating tobacco is very laborious and expensive and only the abundance of cheap coolie labor permits this practice in Sumatra. What advantage this method has over the system in vogue elsewhere, is hard to determine; the construction of deep canals may be indispensable in Sumatra because of the even distribution of rainfall throughout the year. The primary purpose of these canals is to drive out or to get rid of the excessive water that may likely flood the plantation. This Sumatra method of growing tobacco has been tried in the Philippines, but results obtained thus far are not as yet very satisfactory.

Control of tobacco worms.—As the primary object in growing wrapper tobacco is to produce sound leaves, one can readily see

the importance of vigilant control of all destructive pests of the crop while it is growing in the field. The false budworm, the cutworms and the hornworms are universally admitted to be the most destructive insect enemies of the tobacco plant from the seed bed until the last leaf in the field is harvested. It requires an army of worm pickers to keep the worms fully under control. This is accomplished either by hand picking, by spraying, or dusting the buds of the plants with arsenicals. Of course, the production of wrapper tobacco under tents minimizes the damage of these worms on the crop but does not entirely check their destructiveness. Calcium and lead arsenate are among the best insecticides for the control of tobacco worms. These arsenicals, when used in solution, should be in the correct concentration to avoid the burning of the leaves, otherwise their application would be more destructive than beneficial. In Sumatra as in the Philippines, 300 grams of the arsenical powder was found to be the best basis for dusting. That is, every 100 grams of sifter or carrier, like wood ash or sterilized road dust, should be mixed with 5 grams of the arsenical powder, or in the proportion of one part powder to 20 parts carrier.

Topping and suckering.—Topping and suckering are two distinct operations having a common end. Topping is the removal of the flower head by pinching, while suckering simply means the removal of all suckers or buds at the axils or junctions of the leaves. The work on suckering and topping requires the exercise of some discretion. At or about the time when the plants are beginning to flower, practically all the food material which are being taken in by the plants are utilized for the nourishment of the flower head and the top leaves. Opinions regarding topping vary. There are growers who believe that topping is a necessary operation, while there are others who insist that topping can be dispensed with entirely in the production of wrapper tobacco. The reason is obvious. Topping is believed to thicken the leaves. On the other hand, untopped plants are supposed to produce a crop of bitter taste. The writers' opinion is that topping is discretionary. When a plant apparently is not in a vigorous condition, it should be topped so that the plant food, instead of being consumed by the flower head and top leaves, can be utilized for the development of the standard leaves. When the plants are vigorous enough, topping ought not be undertaken since this operation favors the development of coarse, thick leaves. If resorted to, however,

it should only be performed when the standard leaves are already harvested. The plants for the production of seed should, of course be selected first, then the rest of the plants can be topped. Suckers do not appear abundantly until after topping, so that suckering is a subsequent operation. Suckers deprive the plant of a great deal of food and therefore, should be removed as soon as they appear. After the standard leaves are harvested, two suckers from the base can be allowed to develop for the production of filler or binder. This crop is usually termed "retoño." Sometimes suckers are allowed to grow when the main plant has been damaged in order to replace the loss.

Harvesting.—In harvesting wrapper tobacco, the leaves should be primed, that is, picked singly from the stalk as soon as they show the right maturity. It is hard to make a definite rule as to when exactly they are ready for picking. Of course, it is fairly easy to distinguish a mature leaf from a green one, but to harvest a leaf at the proper degree of maturity in order to obtain a good crop and do so throughout a whole harvesting period is a delicate operation. Only by experience does one become a successful operator. An almost uniform color of cured crop is easily obtained if the uniform maturity of leaves is maintained upon priming. If a leaf is picked green, it has, when cured, an undesirable dark color and a bitter flavor; when picked overmature, texture and flavor are also affected. Among visible indications of ripening are the slight yellowing of the edges of the leaves, especially at the tip, and the changing of the entire color of the leaf from deeper to lighter green. Priming on every plant should be done at least once a week. By the adoption of this schedule, it will take from 5 to 8 primings to harvest an ordinary wrapper crop. In the course of priming, the leaves are piled along the rows as the load becomes too heavy to carry along. These piles are in turn gathered into convenient baskets and taken to the curing barn. Great care must be taken in handling the leaves during priming so as to avoid mutilation, breakage, or scratching, since the slightest injury to the leaves is a permanent damage to the finished product. Opinions among tobacco men as to the time of day for the harvesting of wrapper tobacco differ. Some growers advocate the harvesting of the crop only during early morning, when the plants are not yet actively doing photosynthetic work; it is supposed that the leaves are then in finest condition. On the other hand, other

growers contend that harvesting wrapper tobacco when the leaves are still wet not only diminishes the gum but also causes them to sweat readily, producing an undesirable black color which kills the finish of the leaves and easily brings about decay. For this reason, priming should be done not earlier than 9 o'clock in the morning. The experience of most growers, however, is that in most cases the time of priming need not be limited but can be carried on continuously from morning till afternoon every day. This is the case with big plantations where it takes a week or more to complete the cycle of one priming in a big field. Harvesting goes on irrespective of whether the leaves are wet or dry, or whether it is morning, noon, or afternoon, since to delay the harvesting is far more detrimental to the crop as a whole. The most important thing to remember is that the leaves must be harvested at the proper degree of maturity or ripeness. One precaution that should not be overlooked is to make certain that all leaves are poled before the day ends. Harvests should not be allowed to lay in big piles overnight, because when allowed to do so for a considerable length of time the pile sweats and develops heat that destroys the quality of the finished product. Other than this, there seems to be no valid reason for exactly limiting the hours of harvesting. Neither is wilting a necessary process preparatory to poling or stringing. On the contrary, fresh turgid leaves are easier to handle in poling than wilted ones.

V. THE GROWING OF WRAPPER LEAF TOBACCO UNDER SHADE

The practice of growing wrapper tobacco under shade is quite a recent innovation. In Florida an attempt was made to introduce the raising of tobacco by shading in 1896. The initiator of this idea was A. D. Shaw of Quincy, Florida. The first effort proved unsuccessful. Lath shade supported by posts was first tried. Later, in 1900, the trial was made in the Connecticut Valley on the farm of John Dubon of Poquonock County. This experiment was under the auspices of the United States Department of Agriculture. A shelter tent of cheese cloth was used instead of lath shade. In 1902, the officials of the Connecticut Agricultural Experiment Station of New Haven announced that, "no further evidence is required to demonstrate that tobacco of the Sumatra type can be grown in the State

of Connecticut which is equal in all respects to the average imported Sumatra." It will be remembered that the variety first tested, both in Florida and in Connecticut, was the Sumatra variety, as it was the aim of the experiment to produce Sumatra wrapper from the Sumatra seed that would be just as good as the imported Sumatra. The Sumatra variety, howver, did not make good. It was found later that it does not produce a good crop in the United States. The shading experiment nevertheless succeeded, after many reverses, by the use of the acclimatized Cuban seeds. At the present time the Connecticut Valley annually produces from 70 to 80 per cent of all the shade-grown wrapper tobacco of the United Sttes, mostly of the Broadleaf and the Havana seedleaf varieties. The use of artificial shade involves considerable expense, but the high prices offered for shade-grown crops have justified the practice. To-day the use of shelter tents in growing wrapper tobacco is not confined to the United States, but is also resorted to in Cuba, Puerto Rico, and in the Philippine Islands. The principal purpose of shading is to produce a 60 per cent shade for the protection of the plants from direct exposure to strong sunlight, to conserve moisture, and to lessen damage by insects. All other phases of the work are governed by the same principles that hold for the open-grown wrapper.

The following description of a shelter tent is from Bulletin No. 138 of the United States Department of Agriculture, Bureau of Plant Industry:

> Too much stress can not be laid upon making the tent frame strong in every way, so that there will be as little given to it as possible. The outside posts should be well guyed, so that the wires will remain taut when stretched. Much trouble is often caused by the main wires to which the cloth is sewed, becoming so loose that the pull of the cloth can move them up and down. This gives the cloth a chance to jerk and break the cord which holds it to the wire, causing a rip, which is difficult to repair. The most economical distance to set the post is 24 feet apart each way. To set them further apart is not safe because the strain upon the cloth in a high wind involves the danger of loosening the covering at a critical time.
>
> In preparing to erect a tent the first essential is to lay off the land and place a small stake where its post is to be located. To this, start at one corner and lay off a square and set a side and an end row of stakes across the field at right angles to each other, sighting them in line and measuring the distance to put them apart in the row. When

this is done the rest of the field can best be laid out by the use of a triangle the sides of which are the desired length. Put one leg of the triangle against the row of stakes and the other leg against the side row and place the new stake in the corner of the triangle. Repeat this until all of the places for posts are marked.

The digging of the holes is a simple operation and consists of removing a small portion of the top soil with a shovel and then deepening the hole to the desired depth, which should not be less than three feet, by the use of a common post-hole digger. The post should be cut at least 11½ feet long and set three feet in the ground, this marking the tent 8½ feet high. When the variety used is tall-growing the tent can be made a little higher. In aligning the posts the tops should be sighted and leveled by lowering or raising a post where necessary, the rows being kept straight.

To guy a post, a timber not less than four feet long and six inches in diameter, to which is attached a No. 9 wire, should be sunk in the soil to a depth of three feet, not less than six feet from the base of the post, and the other end of the wire made fast to the post. This done the next thing is to stretch the wire. First, run the main No. 6 wire to which the cloth is to be sewed. Make one end fast to the top of an outside post and stretch the wire tight by the use of a block and pulley or some other powerful means of pulling and fasten it to the top of the post at the other end of the field. This wire should be fastened firmly to the top of each post in the row.

After all the main No. 6 wires have been put on and fastened, cross wires should be run on the top of these. At the top of the cross rows of posts use No. 9 wire, and at intervals of four feet between the posts stretch a No. 12 wire, fastening it to the outside wires on the sides. At the crossing of the two wires, they should be fastened by twisting about them a short piece of small wire; No. 16 wire is a convenient size for this purpose. At the bottom of the outside posts run a No. 9 wire for the purpose of fastening the bottom of the cloth.

The cloth used for the tents comes from the mills sewed into strips 84 feet wide and usually 60 yards long. This cloth is run on the wires by threading it under one cross wire and over the next one, and where the ends of the strips meet they are sewed together. The edge of the cloth is now wound around the wire and made fast by sewing with strong twine. The operation is repeated until the whole field is covered and the tent complete.

In the Philippines, bamboo which grows everywhere is used as frame for shelter tents and the leaves of coconut and nipa palms are cheap materials for shading. As a rule the shade frame is erected as early as is practicable, at times put up even before transplanting. The shading materials are placed when the plants are about half a meter high. Shading of the field when the plants are still very small should be avoided since it tends to make them tender, weak, and slender. But once the shading is begun, it should go on without interruption or delay; the sooner the shading is completed the better, as a

more uniform crop will be obtained. Great care must be observed in equalizing the even thickness of the shade, as uneven shading results in the production of a crop of various degrees of fineness. The posts of the frame must not be less than 2.5 meters high and must be set lengthwise after every 4 rows of plants and crosswise after every 6 to 8 rows. They must be buried deep enough (3 feet) to resist strong winds. In places where palm leaves are not available the use of talahib (*Sacharum spontaneum*) and cogon grasses (*Imperata cylindrica*) is resorted to.

Shading has various effects upon the crop. Partial results obtained in the Philippines show that shading tends to increase area, diminish weight, improve burning quality, accelerate growth and maturity, and, above all, render the leaves thin and of a light color. In the United States cheese cloth containing 12 threads to the inch produces higher and better crops than similar material with more or less than 12 threads to the inch. In other words, a shade made of any of the above described materials that approximately allows only 40 per cent sunlight to pass through is the most appropriate shelter tent for obtaining the best results. An experiment is now under way in the Philippines wherein the use of abacá cloth for shading tobacco plantations is being studied. If the experiment proves successful, it will mean an added economy on the part of the growers. The material is cheap, considering the present low price of abacá, and it could be used for a period of three or more seasons.

The shading of wrapper-tobacco fields has many other advantages. It greatly minimizes, if not altogether controls, the fussarium wilt disease of tobacco. This has been amply demonstrated by the test conducted for the last three years in the wilt-ridden districts of La Union Province in the Philippines. The shaded soil, retain more moisture, and the cooler atmosphere of the shaded plantations seem to be the favorable factors. Shading also affords more food for the plants, so that stunting is eliminated. Because the soil is not packed by alternate drying and wetting, it remains in better physical condition. The lower temperature in the tent approximately equals the established optimum growing temperature. Furthermore, as Stewart claims, "there is less variation in the temperature in the tent which is generally recognized as a factor of great importance."

TABLE 7.—*Showing Stewart's observation on the effect of a tent on soil moisture, temperature, relative humidity, and wind velocity*

Observations	Average soil moisture	Average temperature	Average relative humidity	Velocity of wind
	Per cent	*Fahrenheit*	*Per cent*	*Miles per hour*
Inside of tent	14.7	72.8	79.0	1.00
Outside of tent	11.6	71.4	71.7	10.00
Difference	1.4	1.4	7.3	9.00

The advantage derived from greatly increased relative humidity of the atmosphere by shading is well defined by Strassburger, Noll, Schenck, and Schimper:

> It acts as a stimulus, and also, by diminishing transpiration, increases turgidity.

The velocity of the wind is very much reduced, which decreases evaporation and protects the plants from being whipped, brushed, or blown down.

Dr. H. Hasselbring, while conducting tobacco experiments in Cuba, claimed to have found that plants grown in the open absorbed and transpired the greater quantity of water, contained the smaller percentage and the smaller absolute quantity of ash.

Some of the conclusions reached by Lutzer show that abundant sunlight, high temperature, liberal nitrogen manuring, and sparing use of water in the soil, produce a large percentage of nicotine; also, that the direct sunlight favors a high potassium but a low chlorine content.

In shade culture the ideal large-sized varieties for wrapper are preferable to the small-sized varieties to compensate the high cost of production by obtaining a higher yield per unit area. In the United States, the Broadleaf is now the dominant variety for shade culture, although in the beginning the Sumatra varieties were tried. The growing of Sumatra types under shade was finally given up, and in their place were substituted the acclimatized Cuban varieties. The same thing is happening in the Philippine Islands.

VI. CURING SHED, CURING OPERATIONS, FERMENTATION, CLASSIFICATION, AND BALING

The curing shed.—While substantial farm barns which are spacious and well ventilated may be utilized for curing tobacco,

it is always better and more profitable in the long run to have a standard curing shed exclusively for tobacco. This is particularly so in the case of wrapper tobacco, wherein a delicate and costly product is desired. As a general requirement, wrap-

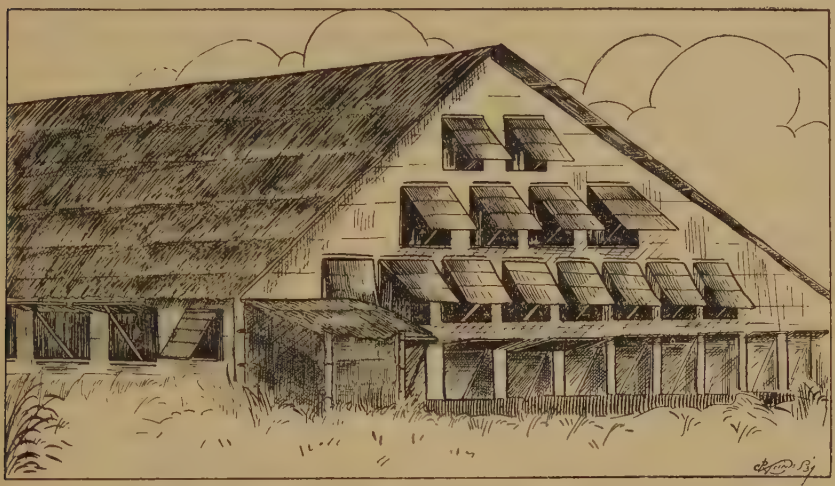

FIG. 1. A typical curing shed for wrapper tobacco in Sumatra.

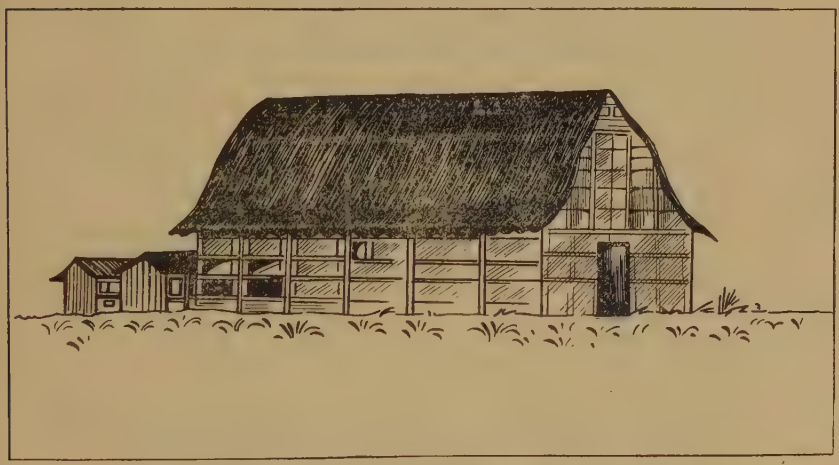

FIG. 2. A typical curing shed for wrapper tobacco in Cuba.

per-tobacco curing sheds should be spacious and the inflow and outflow of air well controlled by an adequate ventilation system. Successful growers in the United States have adopted many different systems of ventilation, the most common of which are the following: (1) Top ventilation secured by means of

slatted ventilation set in the gable ends of the shed or in the roof along the ridge pole, or by means of valved, cylindrical metal ventilations set in the roof peak; (2) sill ventilation constructed either by inserting loose boards vertically at intervals of a few feet along the side walls of the barn or by hanging horizontal boards above and fastening them to a common lifting rod. The boards are fixed to the sides of the sheds at points near the lower end of each tier; and (3) bottom ventilation sometimes is resorted to by making the floor beam project on each side beyond the foundation walls. The wall plates rest upon the ends of these beams, forming trap doors when the floor between these two walls is raised. Many of the most modern curing sheds now in use in the United States are provided with ventilation systems combining two or all of the above described types.

For an idea of the materials necessary for the construction of a permanent curing shed under United States conditions the following data of estimates of materials for the construction of a permanent curing shed capable of curing a crop from a 100-acre farm is hereby given. This data is obtained from the No. 62 Report of the United States Department of Agriculture:

1. Sills, 22 pieces (6″ x 6″ x 20′ or 1,320 ft.)
2. Studding, 24 inches center (160 pieces) 2″ x 4″ x 18′ or 1,900 ft.
3. Plates, 14 pieces (2″ x 6″ x 20′) or 280 ft.
4. Rafters (26 inches centers) 88 pieces, 3″ x 6″ x 34′ or 188 ft.
5. String back for rafters, 6 pieces, 3″ x 6″ x 32′ or 288 ft.
6. String back for supports, 14 pieces, 3″ x 6″ x 8′ or 168 ft.
7. Uprights for tiers, 10 pieces, 4″ x 4″ x 21′ or 280 ft.
8. Uprights for tiers, 10 pieces, 4″ x 4″ x 29′ or 230 ft.
9. Upright for tiers, 10 pieces, 4″ x 4″ x 27′ or 360 ft.
10. Uprights for tiers, 10 pieces, 4″ x 4″ x 30′ or 400 ft.
11. Tier poles, 240 pieces, 2″ x 4″ x 16′ or 2,560 ft.
12. Ribbons, 56 pieces, 1″ x 4″ x 20′ or 274 ft.
13. Cross braces, 14 pieces, 1″ x 6″ x 25′ or 165 ft.
14. Ventilators, 16 pieces, 1″ x 12″ x 12′ or 192 ft.
15. Ventilators, 32 pieces, 1″ x 12″ x 10′ or 320 ft.
16. Sheating for roof, 2,750 ft. 1″ x 3″ or 2,750 ft.
17. Weather broading, 4,500 ft. 1″ x 6″ or 4,500 ft.
18. Door and shutters, 1,000 ft. 6 and T ceiling or 1,000 ft.
19. Pillars, 2,000 bricks.
20. Pillars, 2 barrels, stone lime.
21. Singles, 6 inch to the weather, 30,000 (4″ x 18″) cypress.

22. Ventilators, 50 pairs, 8 inch strap hinges.
23. Shutters, 22 pairs, 8 inch strap hinges.
24. Door, 3 pairs, 12 inch strap hinges.
25. Ventilator levers, 24 angles brackets.
26. Shutter props. 11 pairs, 6 inch T hinges.
27. Intermediate tiers for primed tobacco.

(*a*) 5,200 ft. barn wire.
(*b*) 20 pounds staples.
(*c*) 2 kilos 4 penny cut nails.
(*d*) 3 kilos 10 penny cut nails.
(*e*) 2 kilos 20 penny cut nails.

The building is 36 by 96 by 16 feet. From sills to plate tiers, 4 tiers; 13 feet from plate tiers to point roof, 2 tiers; all the tiers are 4 feet apart each way. This number of tier poles is enough when the tobacco is harvested by stalk. When the tobacco is harvested by priming, the number of tier poles is doubled in quantity by stretching heavy wire so as to alternate with the original tier. The building may be painted or not as desired.

In the Tropics; in Sumatra, Cuba and in the Philippine Islands, for example, the roofing and the sidewalls of curing sheds are made of light materials, like bamboo and nipa palms. The frames are, of course, made of strong lumber. The following is an estimate of materials used in the construction of one curing shed capable of curing a crop of 3 hectares under Philippine conditions:

DIMENSIONS OF BUILDING—50 M. X 20 M. X 3 M.

1. 40 ipil posts (6″ x 6″ x 12″)	₱280.00
2. 10 ipil center posts (6″ x 62″ x 25′)	140.00
3. 14 pieces apitong, for grits (3″ x 6″ x 30′)	42.00
4. 800 pieces big bamboo of rafters, beams, studs, wall frames and braces, door and window shutters, tier poles, etc., etc.	120.00
5. 12,000 nipa pingot (shingles) for roofing, walls and window and door shutters	100.00
6. 2,000 pieces splitted rattan for tying	20.00
7. 5 kilos of 5-inch nails	3.00
8. 5 kilos of 3-inch nails	3.00
9. 500 pieces, small bamboo for racks	20.00
10. Miscellaneous expenses	50.00
11. Labor construction	300.00
Total	1,078.00

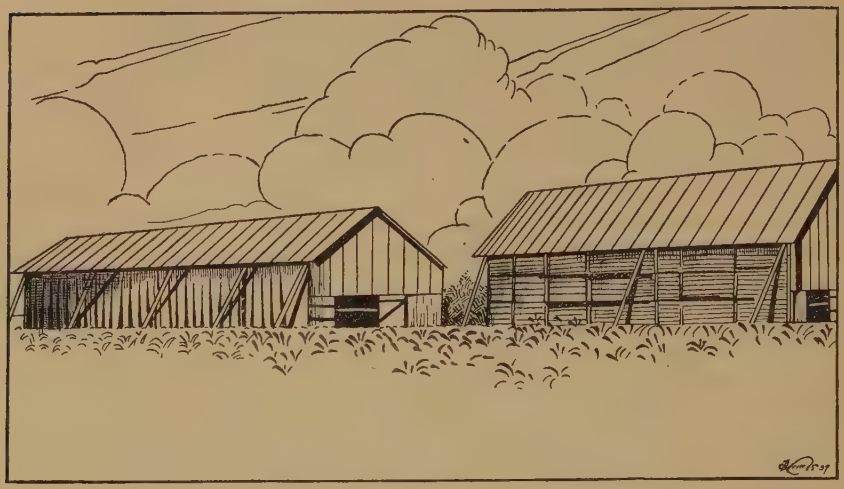

FIG. 3. Typical curing sheds for wrapper tobacco in the Connecticut Valley, U. S. A.

Poling and stringing.—When the leaves are brought to the curing barn, they are laid on the floor or table with great care to avoid folding, scratching, or mutilation. The fresh leaves are poled and strung immediately. If the crop is very uneven in size and soundness, it is first sorted for such soundness and size preparatory to stringing. The method of stringing and poling tobacco in Cuba and in the United States is similar. A big needle, a string, and a pole or lath are used. One end of the string is fastened to one end of the pole while the other end is attached to the needle. The needle is passed through the petiole of the leaf in such fashion that the leaves are strung face to face and back to back, allowing two fingers distance beween leaves. A pole four feet long usually contains from 36 to 45 leaves. When the pole is full, the end of the string is tied at the other end of the pole, stretching it well before tying. The strung and poled tobacco is then ready to be hung on the racks at a foot distance from one another for free circulation of air.

In the Philippines a pointed bamboo stick called "palillo" is used instead. The sticks are of different sizes, the big sticks for the big leaves and the small sticks for the small leaves. The sticks or palillos are provided with butts at one end to keep the tobacco from sliding off, and when the stick is full of tobacco, the other end, which is sharpened is corked with soft pitched wood or a slice of pummelo peel to prevent the leaves from falling off. To facilitate the sticking, a sword-like thim-

ble made of thin tin or other metal is inserted upon the sharp end of the stick. The thimble pieces the petiole of the leaves sharply without breaking them. The leaves are strung face to face and back to back with a finger's distance each. The method of poling and stringing wrapper tobacco in Sumatra is the same as that employed in the United States and Cuba.

Curing.—Curing is not mere drying of the leaves as most people think. The failure of most growers is due mainly to their utter disregard of the rules governing curing-shed operation or the absence of a suitable curing barn. Curing is essentially a life process. This is evidenced by the fact that the protoplasm of the leaf killed by excessively low or high temperature or by chemical treatment like chloroform prevents normal curing. Imperfect curing can not even be corrected by fermentation processes. The chemical changes which take place in curing are the properties of active substances. In a thoroughly air-cured crop, all the starch and reducing sugars disappear and there is a decrease of protein, nicotine, and total nitrogen content. Appreciable quantities of ammonia are formed in the process. The physiological processes during curing are brought about by the aids of diastatic, proteolytic, and deamidizing enzymes and probably also of oxidases. The starvation to which the leaves are subjected leads to an increased secretion of diastase. Thorough and gradual wilting during the initial stages of curing promotes the progress of the process, provided further curing of the leaf is not allowed to proceed too rapidly. Herein lies the danger of applying too much heat; therefore, the application of the same, if resorted to, must be moderate.

In tropical regions, wrapper tobacco is cured solely and completely by air in a slow, gradual manner. Freshly hung leaves are allowed to wilt by closing the ventilation for a period of 3 to 5 days, after which the ventilation is opened to allow free circulation of the air. After the wilting period the ventilation is opened every day except on windy and foggy days. In no case, however, should it be opened at night. Under Philippine conditions, curing is effected in from 24 to 32 days. In temperate countries, as in the Connecticut Valley in the United States, air-curing of wrapper tobacco is aided by artificial heat, either by charcoal braziers or a flue-heating system. This method of curing affords the only practicable means of preventing decay and the attack of leaf molds due to excessive moisture during cold weather. In other words, the curing of wrapper

tobacco in cold regions is accomplished by the combined use of artificial heat and ventilation. The application of heat is, however, rigidly regulated, and resorted to only when absolutely necessary.

Complex chemical reactions take place during curing. They cannot be fully explained at present because knowledge on this phase of chemical and physiological activity is rather scant. It is the general assumption that curing is the getting rid of at least 75 per cent of the water content of the fresh leaves, but this assumption is rather a makeshift explanation to cover the lack of proper understanding of the principles underlying the process of curing.

Before any tobacco is brought in to cure, the curing barn and its surroundings must be thoroughly cleaned, leveled, dried, and disinfected, if necessary. The cleanliness of the curing barn and its surrounding is here emphasized because the occurrence of fungus diseases due to dirtiness, damp soil, etc., often causes the destruction of a large portion of an otherwise good crop. The poled or strung tobacco is admitted and placed on the racks beginning with the highest series until the curing barn is full. To permit a slow wilting process, the ventilation is closed from three to five days. As the wilting period terminates, the yellowing stage begins, usually lasting from 7 to 10 days. The green color of the leaves gradually turns yellow; this change is regarded as the slow starvation of the leaves. The flow of air and the rate of yellowing must be regulated in order to allow a slow transformation. The last stage, that is, the turning of the yellow color to brown, emerges. This browning is due to the yellow pigment being oxidized by the action of enzymes found in the cell of the leaf. At this period the sugar and starch in the leaf disappear, together with some albuminoids and tannins, while the amount of nitrogenous bodies increases. The real drying now begins and must not be retarded until the sap of the midrib, which is the last to dry, is desiccated. The fixing of the color of the crop is also done at this stage. All ventilation should be opened daily, if weather conditions permit. When exigencies demand, the charcoal braziers or the heating system may be operated. Rapid drying is desirable to fix the color promptly, as an excess of moisture may likely blacken the crop. This stage lasts from two to three weeks. Ventilation should not be opened at night as the crop readily absorbs moisture to any amount, and this causes mold and decay. During the cur-

ing process the tobacco on the racks should be regularly shaken to throw off the worms that are feeding on the curing leaves. The last series of racks should be not lower than a meter from the dirt floor. If the barn is floored with either wood or cement, the lowest series of racks can be placed lower than a meter. This precaution prevents the leaves on the lowest racks from absorbing the moisture evaporating from the soil.

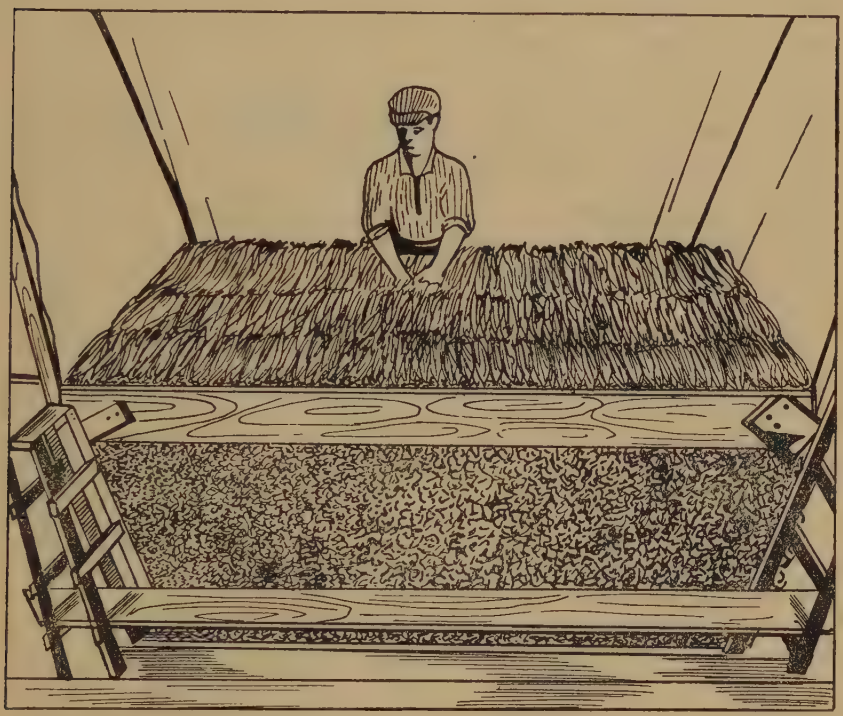

FIG. 4. Method of sweating wrapper tobacco in the United States

Fermentation.—The crop is ready for fermentation when the leaves are well dried and the midribs well desiccated. A thoroughly cured wrapper tobacco must also be in the proper condition or in "good order" before it can be fermented. Very dry tobacco, besides being too brittle to handle, does not develop heat and therefore, does not ferment readily, while too soft tobacco, when piled, is likely to burn due to the almost instantaneous development of excessive heat which moist tobacco can not withstand. Crops ready for fermentation should be neither too dry nor too moist, but must be pliant enough to permit handling. This condition can be easily determined by holding a fair-sized

bundle of the crop, pressing it firmly within the hand and then withdrawing the hold. If the bundle, upon being released, gradually unfolds and slowly returns to its former natural position, the tobacco is in good condition for fermentation. If the tobacco remains firm and intact when released, it is too soft for fermentation and should be allowed to dry until the desired

FIG. 5. A method of pilling wrapper tobacco in Sumatra for fermentation process

pliability is reached. Dry tobacco should never be sprayed with water or exposed to the open air for cooling, but should be hung in the curing barn either in the evening or early in the morning. When the crop is in "good order," it is removed from the poles or palillos and bundled into hands of convenient size. The sand leaves, standards, and tops are handled separately, and if the crop is large, fermented separately. A clean closed room, if a separate building is not available, should be used for fermentation. The crop is piled in bulks by sections and turned over regularly at least once for every 4 degrees rise in temperature. The object of turning is to reverse the construction of the pile,

bringing the top, bottom, and the outside layers into the middle of the new pile. For convenience, the pile should not be more than 2,000 to 3,000 pounds. It takes from 6 to 8 weeks to thoroughly ferment a crop. The object of fermentation is to make the crop more homogenous in color and to improve, mellow, and preserve it from decay. The changes that take place during fermentation, as per Table 8, are: (*a*) considerable loss of water and dry matter, (*b*) increase of ammonia, (*c*) decrease of nicotine, (*d*) disappearance of sugar, and improvement of flavor and aroma.

TABLE 8.—*Showing composition of 1,000 pounds of unfermented first wrapper leaves and the lose of each ingredient during fermentation (after Jenkins).*

Ingredients	In 1,000 pounds unfermented	Left after fermentation	Loss in fermentation
Water	275.0	226.2	48.8
Dry matter	725.0	683.1	41.9
Ash [1]	158.3	147.5	10.8
Nicotine	12.5	10.5	2.0
Nitric acid (N^2O^5)	25.9	21.3	4.6
Ammonia (NH^3)	3.3	4.3	[3] 1.0
Other nitrogenous matter [2]	113.1	105.6	7.5
Fiber	99.0	94.8	4.2
Other nitrogen:			
Free extract	255.6	244.5	11.1
Ether extract	28.4	26.4	1.8
Starch	28.9	28.0	0.9

[1] Free from carbonic acid and carbon.
[2] Nitrogen other than that of nicotine, nitric acid, and ammonia multiplied by 6¼.
[3] Apparent gain.

Contrary to the popular belief of the agency of bacteria in fermentation, Doctor Loew attributes fermentation of tobacco to the action of soluble ferments or enzymes formed in the growing plants and during the wilting period after harvest. He claims that in tobacco fermentation, the main changes are the result of chemical action wherein oxygen of the air is made to unite with the various compounds in the leaf. These oxidizing enzymes he calls oxidase and peroxidase. The oxidase, while a very active oxidizing agent, is readily destroyed or converted into ordinary protein at a temperature of about 152° Fahrenheit, while the peroxidase is more stable. Both, however, disappear after

sweating or after fermentation and upon aging. Other workers, however, believe that tobacco fermentation is due to the activity of bacteria which have the ability to produce heat during fermentation. According to Schmidt (1925) the mesentericous bacteria are found on Ohio tobacco of good quality, and the coccus form, on tobacco of poor quality. Experiments conducted by the Philippine Bureau of Science have also disclosed the fact that bacteria play an important rôle in tobacco fermentation. The petuning of tobacco in the United States has possibly no other purpose than to stimulate the growth of or to infect the leaves with the desirable bacteria. While the activity of non-living ferments (enzymes) on tobacco fermentation cannot be denied, yet the rôle that bacteria play in tobacco fermentation is hard to ignore. It appears more logical to assume that both enzymes and bacteria activate if not altogether bring about, the result of fermentation.

In Cuba, the United States, the Philippines and Porto Rico, the methods of fermentation are virtually identical. In Sumatra, however, the method is so novel that it deserves a special mention.

The fermentation of a regular big crop of wrapper leaves from a single estate in the island of Sumatra is done in a series of gradual combinations of the fermenting piles or mandalas which are initially of small size. For convenience, let us call the series: A, B, C, and D. Each step in the series as a rule is characterized as to size and temperature allowed in each as follows:

A Series (*first piles*).—About 1,000 to 2,000 kilos of leaves are piled into bulks of 2.5 by 2.5 meters by about 30 layers and the temperature allowed is from 48° to 50° C. within 9 days.

B Series (*second piles*).—Each pair of A piles is now combined forming 3 by 3 meters by about 33 layers bulks with about 2,000 to 4,000 kilos of leaves and the temperature allowed to rise to 50°–54° C.

C Series (*third piles*).—Each pair of B piles is at this stage combined also, forming 4½ by 3 meters by about 40 layer bulks and the temperature further allowed to rise 54°–58° C.

D Series (*fourth and last piles*).—Lastly, each pair of C piles is combined to form 4.5 by 4.5 meters by about 50 layers or 3.75 by 5 meters bulks. The maximum temperature of 56°–58° C is the limit allowed to develop in this series.

Because of the tremendous amount of the crop, many piles are naturally made under each series. And the piles under the first

or A series are designated thus: A–1, A–2, A–3, A–4, etc. The whole process may last from 45 to 75 days.

The foregoing method ought to be a sound practice inasmuch as it is universally followed in that famous island but our own experience in the Bureau of Plant Industry stations where it is impossible to raise wrapper tobacco in a commercial scale, has shown that small piles about 2.5 meters square and the height the equivalent of about 30 layers of hands, can be allowed to heat to 56° C. and even to 58° C. with satisfactory results.

Classification and sorting.—Many a good standing crop is spoiled for the market by improper sorting and classification. Classification requires skill, and experienced sorters on a tobacco estate are indeed a great asset. As the tobacco cannot be handled when brittle, the sorting is deferred until the cool season begins, when the crop is pliant enough to be handled. A well lighted or ventilated room is the proper place for classification work, as the different shades of color can thus be easily distinguished. A sorter squats on the floor with his back towards the light. In front of him is a fence of sticks or boards arranged in a semi-circle with convenient spaces between the sticks where the classified product is laid in piles. Every space corresponds to a grade or class. Beside the sorter is a pile of the unclassified crop. The sorter takes a bundle, examines it leaf by leaf and places each leaf in its particular section. A glance is sufficient for an experienced sorter to decide to which class a leaf belongs. The various shades of color are easily differentiated by a trained eye. Slight variations in color are, however, less important as a basis in sorting than quality evidenced by fineness of texture and light uniform color combined with strength and elasticity. Whenever a sorter is undecided as to which of two grades a leaf belongs he invariably places the doubtful leaf in the lower grade. This practice assures the maintenance of a high classification standard which is absolutely necessary in order to preserve the good reputation of the grower. The sorted crop is then graded according to length. All leaves 15 or more inches in length are classified as first class in length; those of 12 or over but not more than 15 inches are second class; those of 10 or over but not more than 12 inches are third class and those of 8 or over but not more than 10 inches are fourth class. The sorted leaves are finally rebundled in convenient sizes in fan-shaped fashion and are piled grade by grade and left thus until baled.

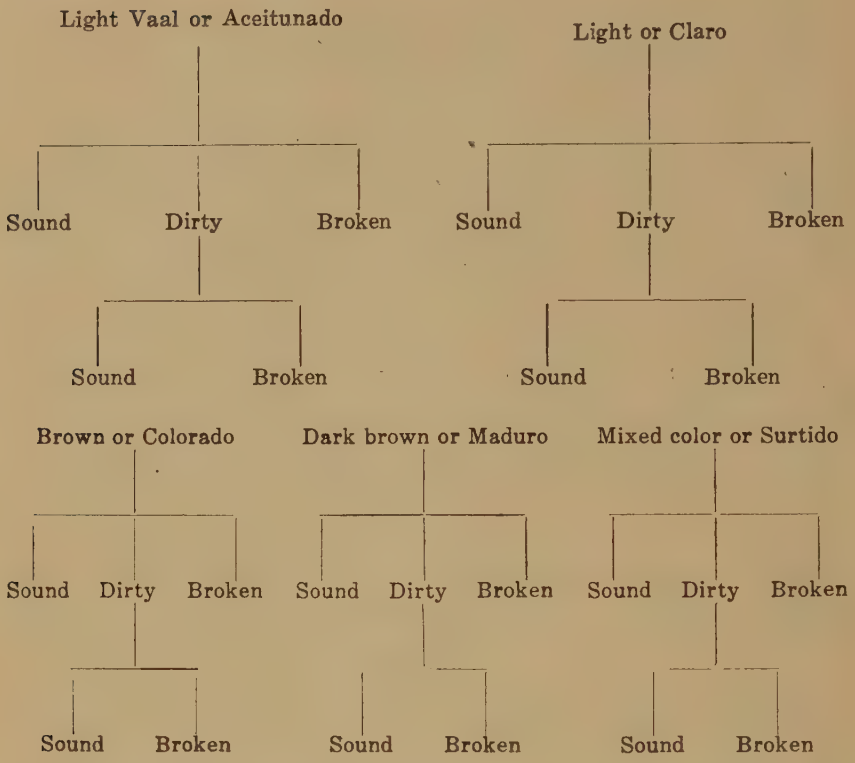

DIAGRAM 2.—Showing classification of wrapper tobacco according to soundness and color.

Abbrevations:

Lv	Light vaal or aceitunado.
L	Light or claro.
B	Brown or colorado.
BB	Dark brown or maduro.
S	Mixed color or surtido.
X	Sound.
Y	Dirty.
Z	Broken.

Classification as to length:

First	15 inches or more.
Second	12 inches and less than 15 inches.
Third	10 inches and less than 12 inches.
Fourth	8 inches and less than 10 inches.
Fifth	all leaves below 8 inches.

In wrapper tobacco classification, the principal criteria are soundness, color, size, fineness, and strength in the order of their importance. As a guide in sorting the diagram of wrapper tobacco classification on this page may prove helpful.

It is unfortunate that the Philippines does not have as yet and official classification or standards for locally grown wrapper

tobacco. The accompanying diagram 2 is proposed by the writers under Philippine conditions. Realizing, however, the tremendous importance of the matter and in order that the authorities or offices concerned can have actual basis for the preparation of Philippine cigar wrapper standards that will meet universal acceptances, appendices A, B, and C are included in this article showing in full the accepted and official standards and baling methods of Sumatra, Cuba and the United States.

Baling.—The product ready for shipment is packed and pressed in grass or palm mats, each bale containing 50 to 80 kilos and measuring 30 inches square and a foot thick. The method of baling is as follows:

A wooden or iron receptacle, consisting of four loose sides without cover, is placed under the press. The mattings are placed at the bottom of the receptacle before the sides are attached. Then the box is filled with tobacco that is already weighed and pressure is applied on the top by means of an iron plate and a screw-like lever. The iron plate presses the tobacco until the desired thickness is reached. The sides of the box are removed and the matting placed and sewed with the aid of iron pins. The pressure is released and the package or bale of tobacco is rolled out and labeled accordingly. The bales are stored in the warehouse, where they are fumigated with carbon bisulphide gas to protect them from the attack of beetles. The tobacco is then ready for shipment or for immediate sale.

Stocks of fine grade wrapper tobacco are sometimes stored in ice plants or in sealed tin containers.

VII. YIELD, COST OF PRODUCTION, MARKETS, THE FLOW OF TRADE, AND THE PROSPECTS OF THE INDUSTRY

The success of growing wrapper tobacco depends largely upon the grower's experience and his ability to keep the cost of production within bounds so as to avoid useless and unnecessary expenditures, particularly under shade culture where the outlay of expenses is very high. Every detail of the work in the field and in the barn must be performed thoroughly, as oftentimes the least neglect results in irreparable loss. Burying the tent posts one inch shallower than is necessary may cause the collapse of the whole structure when struck by a gale of wind. In the purchase of shading materials and fertilizers, it must be borne in mind that the cheapest materials are not

in most cases the best. Beginners should start on a small scale, on an area of a single acre or a hectare. As experience is acquired and the grower becomes familiar with the details of field and barn operations, the area can be gradually increased.

YIELD AND COST OF PRODUCTION

The cost of production of wrapper leaf tobacco as seen in Table 9 varies in different countries, depending upon the standard of living, scarcity or abundance of labor, and the cost of shading materials and fertilizers.

TABLE 9.—*Showing cost of production per hectare of wrapper leaf tobacco in the four principal wrapper-tobacco-producing countries of the world*

(1) SUMATRA—SUN-GROWN CULTIVATED BY BANKING (UNDER PHILIPPINE CONDITIONS)

1. Preparation of land (clearing, 2 plowings and digging of cannals)	₱135.00
2. Curing shed and laborer's quarters	685.00
3. Tools including sprayers	50.00
4. Seedbed materials, palillos, and others	100.00
5. Worm control including cost of insecticide	80.00
6. Rearing 25,000 plants from seed bed to maturity	400.00
7. Harvesting and stringing	150.00
8. Curing and bundling	35.00
9. Fermenting	15.00
10. Classification, leaf by leaf	200.00
11. Baling and baling materials	40.00
12. Incidentals	100.00
13. Capataz supervision based on a hectare unit	60.00
14. Direction based on a hectare unit	60.00
Gross cost per hectare	2,010.00
Minus cost of buildings and equipment after deducting corresponding yearly depreciation	625.00
Net cost per hectare	1,385.00

(2) CUBA—SHADE-GROWN BY USING CHEESE CLOTH

1. Fertilizers	₱320.00
2. Cost of 40,000 seedlings	120.00
3. Preparation of field	80.00
4. Transplanting expenses	60.00
5. Cultivation	150.00
6. Irrigation	70.00
7. Topping, suckering, worming	80.00
8. Harvesting	40.00
9. Curing, poling, and stringing	200.00
10. Depreciation of barn	80.00
11. Depreciation of cheese cloth (50%)	400.00
12. Depreciation of other shed materials	40.00
13. Labor for erecting of tent and removal after harvest	300.00
Net cost per hectare	1,940.00

(3) UNITED STATES—CONNECTICUT VALLEY SHADE-GROWN (USING CHEESE CLOTH ALSO)

1. Interest of one hectare of rented tobacco land	₱72.00
2. Interest and depreciation of farm barn	120.00
3. Interest and depreciation of tent frame	64.00
4. Repairs of tent frame	19.00
5. Cloth to cover frame	731.00
6. Placing cloth on frame	32.00
7. Production of seedlings	70.00
8. Fertilizer	267.00
9. Fertilizer application	5.32
10. Preparation of land	34.74
11. Transplanting	38.32
12. Restocking and poisoning	48.00
13. Cultivation	41.00
14. Topping and suckering	33.60
15. Repairs to tent during season	37.68
16. Straightening of tobacco after storm	4.00
17. Remodelling of barn	30.00
18. Twine	7.24
19. Poling and stringing	92.84
20. Priming and hanging of leaves	225.20
21. Curing and prevention of pole sweat	34.04
22. Delivering tobacco	9.32
23. Removing of cloth and frame after season	19.00
24. Cutting stalks and cleaning the fields	32.64
Net cost per hectare	2,067.94

(4) PHILIPPINE ISLANDS—SHADE-GROWN USING BAMBOO AND PALM LEAVES AS SHADE

1. Seedbed and rearing of seedlings	₱8.00
2. Preparation of field	25.00
3. Transplanting	16.00
4. Cost of shading materials	200.00
5. Erecting shade tent	40.00
6. Worming	20.00
7. Cultivation	15.00
8. Priming and poling	80.00
9. Curing and fermenting	15.00
10. Classification and fermentation	200.00
11. Baling and baling materials	25.00
12. Depreciation of curing shed	60.00
13. Miscellaneous expenses	100.00
Net cost per hectare	804.00

Sumatra wrapper.—In the island of Sumatra, where the famous Sumatra wrapper is raised, the cost of production per hectare is about ₱1,500. Considering the apparently cheap labor of this Dutch colony, this figure seems rather high, especially, since the shelter tent method of growing tobacco is never practiced there. The main reason for this seemingly high cost of production is that all field operations are carried out by manual labor. Not even animal power is utilized. The Suma-

tra triangular method of planting tobacco and its cultivation by the so-called "banking" system is so laborious and expensive that only the presence of cheap coolie labor permits the adoption of this method of growing wrapper tobacco. The outstanding characteristic of the Sumatra method is the laying out of deep canals after every two or more rows of tobacco planted triangularly, thus forming plant beds. The soil dug from the canals is deposited on the plant beds between the plants, gradually raising them. These canals are sometimes about a meter deep from the surface of the raised beds. For every five or more of plant beds larger canals are built for the exit of the small canals, so that the whole canal system resembles trenches. It is built entirely by manual labor with the aid of hoes and shovels. The advantage of this method of growing wrapper tobacco over the shade system is hard to explain but most assuredly the canals serve as a complete drainage system for the plantation. It seems probable that because of the almost even distribution of rainfall throughout the year in the Sumatra tobacco district there is need of getting rid of an excess of water that might otherwise flood the whole tobacco plantation, hence the deep canals. An attempt has been made in the Philippines to imitate this method, and a certain tobacco company with farms in the Cagayan Valley even went to the extent of hiring laborers from Java to work on the tobacco plantations. The results, however, to date are very discouraging and the company is on the verge of giving up the venture. Differences of climate, soil, and wages in the Philippines and in Sumatra are big factors affecting the advisability of this system in the Philippines. Besides, the growing period of tobacco in the Philippines falls in the summer months, so that the problem is not one of how to get rid of water but of how to conserve it. The banking method of cultivating tobacco accelerates soil evaporation through the exposed banks of the plant beds, and therefore deprives the plant of what little water there is in the soil for its nourishment. Except possibly Sumatra and Java, which are successfully producing wrapper tobacco that is among the best in the open culture by the so-called "banking method," everywhere else most wrapper tobacco is grown under shelter tents. What is also important to bear in mind is that Java and Sumatra have not become famous producers of filler or cigarette tobacco and have no local factories, whereas the other tobacco-producing countries, in addition to their wrapper product, produce nearly all

other kinds of tobacco products,—cigar filler, cigarette filler, chewing, lug, smoking, etc.

Under Sumatra conditions a hectare of wrapper tobacco produces an average of from 10 to 13 quintals of marketable wrapper of various grades. When one considers that high-grade Sumatra wrapper sells as high as ₱30 a kilo, one is apt to assume that a tremendous profit is made by the producers. This profit is more apparent than real, because besides the cost of production there is the expense of shipping the crop from the Dutch East Indies to Europe, and before the crop reaches the factories it has to be shipped to the importing country where tariff duty must be paid in addition.

Cuba shade-grown.—Cuba may well be considered the island home of the best cigars in the world. American capital invested in the tobacco industry of Cuba and the progressive American method of tobacco culture and manufacture effected a rapid improvement in the tobacco industry of Cuba. The system of growing wrapper tobacco under shelter tents in Cuba is due to American influence. The cost of production amounts to about ₱2,000 per hectare. This apparently high cost of production is due mainly to heavy costs of fertilizers and shading materials which are imported from the United States. A hectare yields from 1,000 to 1,500 lbs. of marketable wrapper of various grades and a bale of 80 to 90 pounds of fine Cuban wrapper sells as high as ₱200 to ₱1,000. A good portion of the Cuban wrapper is exported to the United States, while the rest is utilized locally for the manufacture of Havana cigars which are exported to all parts of the world. Cuban cigars, more often termed "Havanas," are famous the world over because of the high quality of the filler tobacco.

United States shade-grown wrapper.—The Connecticut Valley and Georgia and Florida are the wrapper-tobacco regions of the United States. The most scientific methods of culture are practiced there, and money is not spared to produce the finest crop. No crop is more heavily fertilized in the United States than tobacco, and, in the production of wrapper, the use of the shelter tent is in vogue. The average cost of production per hectare is over ₱2,000, but in spite of heavy expenditures, the wrapper-tobacco industry of the United States so far is considered one of the most profitable farming enterprises of the American farmers. For a better conception of the wrapper production of the United States and the prices offered for it,

Table 10 is hereby presented, showing the average yield per acre, total production, price per pound, value per acre, and total farm value from 1919 to 1931, inclusive.

TABLE 10.—*United States wrapper-tobacco production and prices, 1919–1931*

NEW ENGLAND SHADE-GROWN, TYPE 6

Year	Average	Yield per acre	Production	Price per pound	Farm Value	Value per acre
	Acres	*Pounds*	*1,000 pounds*	*Cents*	*1,000 dollars*	*Dollars*
1919	4,900	1,178	5,772	105.0	6,060	1,236.73
1920	6,000	899	5,393	100.0	5,393	898.83
1921	7,400	1,019	7,543	95.0	7,166	968.38
1922	8,000	849	6,792	90.0	6,113	764.12
1923	8,500	1,134	9,639	100.0	4,830	1,050.00
1924	6,900	1,070	7,385	85.0	6,277	909.71
1925	4,600	1,050	4,830	100.0	4,830	1,050.00
1926	5,300	1,004	5,322	97.8	5,204	981.89
1927	7,100	899	6,386	105.0	6,705	944.32
1928	8,000	865	6,923	100.0	6,923	865.38
1929	8,700	1,174	10,215	95.0	9,704	1,115.40
1930	7,400	1,042	7,712	90.0	6,941	937.97
1931	5,800	982	5,693	80.0	4,554	789.17

GEORGIA AND FLORIDA SHADE-GROWN, TYPE 62

1919	3,600	1,114	4,012	65.0	2,608	724.44
1920	3,400	1,118	3,800	60.0	2,280	670.59
1921	3,100	1,011	3,135	60.0	1,881	606.59
1922	3,400	1,092	3,714	50.4	2,872	550.59
1923	3,600	1,183	4,260	58.0	2,471	686.39
1924	3,000	1,019	3,058	60.0	1,835	611.67
1925	1,900	1,100	2,090	65.0	1,358	714.74
1926	2,300	1,124	2,586	65.0	1,681	730.87
1927	2,800	1,213	3,396	65.0	2,208	788.57
1928	3,500	1,114	3,900	55.0	2,145	612.86
1929	3,700	1,182	4,373	55.0	2,405	650.00
1930	3,400	1,115	3,790	60.0	2,274	668.82
1931	2,700	1,069	3,101	50.1	1,554	535.86

The above table shows that in 1931, the United States planted about 8,500 acres of shade-grown wrapper tobacco with a total production of about 8,794,000 pounds, valued at $6,108,000. The average yield per acre is about 1,025 pounds with a value of about $662.51 or an average of 65 cents a pound. The Connecticut Valley, which constitutes the major portion of the New England States, produces more and better crops than Georgia and Florida.

Philippine Islands shade-grown wrapper.—The commercial production of shade-grown wrapper in the Philippines is a new undertaking which was started about six years ago in the Cagayan Valley and later introduced in the Province of La Union where it gained a better foothold. La Union Province produces a greater bulk of shade-grown wrapper than any other province of the Islands. The materials used for shading the plantation are either coconut palm leaves or talahib grass (*Sacharum spontaneum*). The cost of production ranges from ₱500 to ₱1,000 per hectare, a hectare yielding from eleven to sixteen quintals of marketable wrapper of various grades. Prices range from ₱0.50 to ₱12 a kilo. The fact that about three years ago the Philippines imported about ₱1,500,000 worth of wrapper from abroad and today only about ₱500,000 is an indication that the industry is prospering, and very soon the country will become self-supporting in her wrapper leaf tobacco needs.

Philippine open-grown wrapper tobacco.—At present and as just pointed out, commercial open cultures of wrapper tobacco in the Philippines are found only in one or two haciendas in Isabela Province. But chiefly because of variable weather conditions, these may eventually be given up. The production of wrapper tobacco in open culture in the Philippines, however, is not entirely hopeless. As may be gleaned in Table 2, there are Philippine regions with climatic conditions virtually identical with those of Sumatra. Although the first attempts in the Cotabato Valley were given up, cultures have been started recently in Davao, Samar, and Negros Occidental.

Even in the Cagayan Valley, although it is not practical to raise a pure wrapper crop in open cultures, by planting the local varieties, especially the Vizcaya, in the field closer (80 centimeters between rows and 70 centimeters between plants in the rows) as high as 15 per centum good wrappers may incidentally be produced from the regular cigar filler tobacco crop.

MARKET, THE FLOW OF TRADE, AND THE PROSPECTS OF THE INDUSTRY

The methods by which growers dispose of their crop vary widely in different countries and even in different regions within a country. In the United States, the auction or loose-leaf floor system; the hogs-head market; the county sales, and the cooperative marketing systems are in vogue. Tobacco crops of

the Dutch East Indies are shipped first to the mother country in Europe where sale is effected by auction in Amsterdam and Rotterdam. During the auction season, representatives of various tobacco firms all over the world gather in Amsterdam and Rotterdam to buy the famous Sumatra wrapper crop. In the Philippine Islands the buying of tobacco by the so-called "papeleta" system, that is, buying tobacco without cash but with the buyers issuing a sort of certificate of sale contract instead, has been practiced for centuries. This method of buying tobacco in the Philippines has been the source of countless difficulties between buyers and producers, and the farmers have in most cases been the victims. Producers sometimes have to wait years for payments for their crop. This disagreeable practice was denounced by the Philippine Government sometime ago and the coöperative marketing system was inaugurated through the efforts of the Bureau of Commerce. The progress of this new movement has been necessarily slow because of the indifference and ultra conservatism of the tobacco producers, but as the farming masses gradually become more intelligent and realize what the Government is trying to do for them, this coöperative marketing system will ultimately succeed.

In many of the cigar leaf districts, however, in countries like the United States, Cuba, and the Philippine Islands, the sale of the crop is consummated on the farm. Buyers or their representatives visit the plantations to determine the approximate quantity and to appraise the quality of the crop, and contracts are entered into between the producers and the buyers. The movement of the tobacco product is international, moving from one country to another. The United States alone imports Sumatra wrapper running to about 5,000,000 pounds annually. At the same time, however, she exports part of her wrapper production to other countries. The Philippines is at present an importer of Georgia and Sumatra wrapper tobacco, her importations running to as much as ₱300,000 annually for United States wrapper and ₱109,206 annually for Sumatra. Table 11 gives an idea of the imports of the United States from foreign countries and from her possessions.

As seen from Table 11 the United States import enormous quantities of Sumatra wrapper, buying over 5,000,000 pounds annually, besides her wrapper imports from other countries,

TABLE 11.—*Imports of cigar leaf tobacco by the United States from foreign countries and possessions*

Product and country from which imported	1923	1924	1925	1926
CIGAR WRAPPER				
	Pounds	*Pounds*	*Pounds*	*Pounds*
Netherlands	7,485,000	5,821,000	6,261,000	6,261,000
Other countries	233,000	73,000	174,000	228,000
Total	7,718,000	5,894,000	6,435,000	6,489,000
OTHER CIGAR LEAF				
Philippine Islands	1,931,000	1,231,000	1,166,000	908,000
Cuba	20,422,000	19,040,000	21,133,000	22,562,000
Puerto Rico	17,838,000	16,370,000	20,258,000	27,261,000
Other countries	5,031,000	3,591,000	163,000	110,000

possibly from Cuba and Puerto Rico. Besides wrapper the United States also imports a large quantity of other cigar leaf tobacco, notably filler and binder, from the Philippines, Cuba, and Puerto Rico. European countries are also heavy importers of wrapper and filler tobacco, mostly from Sumatra, Cuba, the Philippines, and Brazil. There is no other farm crop more heavily taxed and rigidly regulated in its movement than tobacco and its manufactured products. Customs duties, surtax, turnover tax, excise tax, and privilege tax of leaf tobacco dealers and manufacturers are some of the Government charges on tobacco and its manufacture. Tobacco import duties are very high and vary in different countries from 10 per cent to 100 and more per cent ad valorem. Even the internal movement of tobacco and its manufacture in the country where it is grown and elaborated is rigidly regulated and taxed by the government. Yet, in spite of all these impositions and regulations, the tobacco trade flourishes.

To visualize the future of the wrapper tobacco industry of the world, it is important to survey the reaction of the tobacco-consuming public to the different manufactured tobacco products. Before the World War the cigar was the most important product of the tobacco-manufacturing industry. The five-cent cigar was then the pillar of the cigar industry. During the period of prosperity, even the ten-cent and twenty-cent cigars were fast sellers. Then the decline came and the cigarette industry expanded by leaps and bounds until it now predominates

in volume over the various manufactured tobacco products in international trade.

The United States alone increased her cigarette area to nearly 78 per cent of her total tobacco area during the period from 1926 to 1930. Her smoking, chewing, and snuff tobacco decreased 10 per cent in acreage, and from 30 to only 15 per cent of the total area. The cigar types lost 23 per cent in acreage and dropped from 16 per cent to only 7 per cent in relation to the total tobacco area. It appears that tobacco consumers switched to the less expensive products during the period of economics stress. Even the Philippine Islands recently embarked on the production of cigarette tobacco, and her cigar leaf (filler) areas have been gradually decreased to give way to crop diversification. No one can predict with certainty what the future fashion in smoking will be. The cigarette craze may become permanent. Other modes of consuming tobacco may arise; but whatever the future brings, the cigar will continue to be the most valued and the most aristocratic product of the tobacco-manufacturing industry, and as long as this is true, the wrapper-tobacco industry will also persist. During economic depressions there is a tendency among smokers to use tobacco in its less expensive forms, but when normal times return the first yearning of smokers is for the aristocratic cigar.

VIII. TOBACCO PESTS AND DISEASES

The production of high yielding and good quality tobacco has become more difficult in spite of the increased knowledge acquired by growers through experience and experimentation. This difficulty is in a great measure due to the increasing prevalence of tobacco pests and diseases. While new areas for tobacco culture are being opened, the important tobacco districts of the world remained unchanged in location, which simply means that a greater portion of the total area planted to tobacco is intensively and continuously planted to this crop every year. Diseases and pests in these constantly used soils naturally accumulate. It is hard to make an exact estimate of the damage done by diseases and pests to the tobacco industry, but one can get an idea of how tremendous it must be when it is considered that in the United States the loss due to root-rot alone in a certain year amounts to about ₱20,000,000. It is conserv-

atively estimated that the United States losses about ₱50,000,000 of the total value of her tobacco crop annually. In the Philippine Islands, in the province of La Union, approximately one-third of the supposed normal production is being destroyed by the tobacco wilt disease, which means a loss of about ₱800,000 yearly to the province. The most common diseases and pests of tobacco are hereby enumerated, together with causes, when known, and the possible methods of control.

TOBACCO PESTS

From a survey of the various available papers on tobacco insect pests it appears that in tropical as well as in semitropical tobacco regions the damage done by insects is considerably greater than in temperate regions, like the Connecticut Valley. Insect attacks begin almost as soon as the seedlings appear and do not cease until the tobacco is consumed. The damage is mainly of four kinds and may be classified in the following manner:

1. Injury to roots and stems;
2. Leaves eaten or ruined;
3. Leaves punctured by sucking insects;
4. Dried tobacco eaten.

Cutworms.—These insects do vastly more damage to tobacco than all others put together, making it necessary to reset the field or to set nursing plants many times. The latter plan tends to give the crop uneven maturity and quality at harvest.

Cutworms are caterpillars of a number of species of the owlet moth, belonging chiefly to the genera *Peridromia, Agrotis, Feltia, Chloridea, Plusia* and *Prodenia.* Most species have but one brood a year. The eggs are laid on grasses late in summer. The worms as they hatch feed on plants, going deeper into the soil as colder weather comes. In the spring they come out and feed on plants of many kinds. Later they take on the chrysalid form in the ground and emerge as moths. The worms feed at night and spend the day in the ground or under clods or rubbish. In the Tropics their life cycles are virtually uninterrupted. The caterpillar of the genus *Chloridea* is better known as the false bud-worm.

Late fall plowing uncovers many worms which are eaten by birds, and also kill the plant growth which is their early spring food. Undoubtedly rye and other cover crops favor their presence in the field. The best poison bait for them is one pound

Paris green to 100 pounds of bran, a pint or more of molasses and enough water to moisten the whole which is thoroughly mixed. The mash is strewn over the field a few days before setting or placed on rows where the plants are to set. This will kill most of the worms which are ready to attack the crops.

Some growers have found it worth while to put a pinch of this mash near each plant when set and claim that it gives perfect protection. This, however, involves a great deal of labor.

In the Tropics as discussed in a preceding chapter, hand picking is the most practical means of control especially when labor is cheap and abundant. One to two per cent solution of either calcium or lead arsenate spray in the seed beds and in the growing plants in the field, is also practical specially when labor is rather scarce or expensive. Dusting with the same insecticides is preferable as the plants become older.

A parasitic hymenoptera (*Microphitis* sp.) attacks the larvae of the genus *Chloridea* while those of the *Prodenia* by a tachnid fly. A hemipterous insect (*Enagoras* sp.) attacks the larvae of both genera.

Wire worms (*Melanotus cribulosis* Lee and Asaphes *sp.*).—These are the larvae of the click beetles (*Elateridae*) and unlike cutworms can work their way into hard vegetable matter. Occasionally they do serious damage to tobacco, attacking both the roots and the base of the stem. The worm lives for at least three years underground, transforming there after midsummer of the third season in earthen cells. The adult beetles emerge the following spring.

The only suggested remedy is stirring the soil in late summer and fall, which breaks the cells and kills many of the adults. In Cuba drenching the furrows at planting time is the method used to check the pest.

Tobacco horn worms (*Acherontia lacherus and Phlegethontius quinquemaculata* How.).—These worms, the caterpillars of sphinx or hawk moths, are more destructive than any other insect attacking tobacco, excepting cutworms in the United States. The eggs are laid singly on the under side of the leaves by the adults which fly only at dusk. The egg hatches seldom before July into a worm or caterpillar which eats tobacco leaces voraciously until harvest time. The fully grown caterpillar goes into the ground and assumes its pupae or chrysalid form a few inches below the surface to emerge as a moth the next spring. An important natural enemy is a small four-winged fly which

lays eggs in the worm. Its larvae develop there and fasten their cocoons on the back of the caterpillar. A worm thus attacked dies before transforming.

The only control practiced in Connecticut is hand picking. German of Kentucky has shown that one pound of Paris green in 160 gallons of water does not injure the leaf and spraying is practiced somewhat in Kentucky and also in Florida where lead arsenate is used which cannot kill the leaves and adheres to them better than Paris green. In the Tropics the larvae of the sphynx moth is held in check by certain parasitic flies.

Grasshoppers, tree crickets, etc.—Tobacco is often severely damaged by various species of *Orthoptera.* The leaves injured by grasshoppers have holes in them, or perhaps the edges are eaten, the injury being larger than flea-beetle injuries, but usually smaller than thos caused by horn worms.

As a rule the plants on the outside rows, specially when near grass, weeds, or brush, are damaged more seriously than the plants in the center of the field. Certain of these insects make their way to the middle of the field and there feed upon the plants, like the Carolina locust (*Dissosteira carolina,* Linn), the common brown species. The red-legged grasshopper (*Melanoplus femur-rubrum* DeG.) is common in Connecticut, and has been observed feeding on tobacco. *M. atlantis* Riley and *M. differentiales* Thos, have also been reported as feeding on tobacco in Southern United States.

Tree crickets are sometimes injurious around the edges of the field. The commonest is the four-spotted tree cricket (*Oecanthus quadripunctatus* Bent) though the striped tree cricket *O. fasciatus* Fitch, is also found feeding on tobacco.

Other species of *Orthoptera* attacking tobacco in Connecticut are the Texas katydid, *Scudderia texensis* Sanspictet; *S. septentrionalis* Serv; slender meadow grasshopper, *Xipidium fasciatum* DeG, and the short-winged meadow grasshopper, *X brevipenne* Scudd.

Tobacco stem borer (*Gnorimoschema heliopa*).—This is a very serious pest of tobacco, attacking mostly young plants and water sprouts. The young larvae bore throughout almost the entire length of the young stem which eventually swells.

Obviously the stem borer cannot be controlled by poisons since it is well hidden but by insuring the rapid growth of the seedlings thus minimizing their life in the seed beds, infestation is likewise minimized. In the field, vigorous plants can survive an

operation with a sharp knife to kill the larvae. Otherwise the plants that are badly infested should be removed and destroyed.

Tobacco splitworm [*Phthorimeae* (*Gelechia*) *operculella* Zell.].—This insect is an important pest in Southern United States. The adult insect is a minute, grayish moth laying its eggs upon the leaves. The minute caterpillar bores between the surfaces of the leaf making a flat mine, often of considerable size with a gray discoloration visible from both sides of the leaf. There are two or more generations in the course of the summer, and the insect is more noticeable in the autumn.

It has been shown that in Florida this leaf miner when feeding, does not pass its entire life in one place, but after a while gnaw to the outside, and then crawling around over the leaf, will finally enter the tissue again in a new place. From this habit of the insect, it can be controlled by an arsenical spray. The fact, however, that the early generation of the insect is passed in some other food plants like the horse nettle and possibly, the nightshade and the jimson weed, it is recommended that these weeds be destroyed. Clean culture is also advisable.

The new tobacco bug or suck-fly (*Dicyphus minimus* Uhler).—This insect is not only new as a tobacco enemy but is new to science. In Florida, it is considered as a serious enemy of the crop. While the first crop may not be generally damaged, the second as well as late tobacco crop are frequently quite destroyed.

The insects damage the leaves by sucking the cell sap through their beaks. The infested leaves soon become yellowish in color and somewhat wilted, and the older leaves eventually split in places. These conditions render proper curing difficult if not impossible.

The eggs are deposited singly, mainly in the smaller veinlets, hatching after about four days. The entire life cycle of the insect is supposed to be only about 15 days.

A thorough cleaning up of the fields and burning of the trash in autumn are measures which should be adopted when the insects are abundant. The Florida Agricultural Experiment Station has found that a concentrated solution of nicotine, diluted with sixty parts of water, will kill a large proportion of the full-grown as well as many of the young. Spraying should be done in the morning when the insects are less active. Early set trap plants may concentrate the hibernating bugs, so that they can be readily killed.

Other sucking bugs (*Stink bugs*).—There are several true bugs known to suck tobacco juices, causing a shrivelling or drying of the leaf but so far none have been observed to be important enemies of the tobacco crop.

One of the commonest of these bugs is *Precilacystus diffusus* Uhler. This insect is found at all seasons of the year and it really becomes a little menace when very abundant. Another species is the green bug, *Euschistus variolarius.* It has been reported as quite important in Kentucky. An interesting little bug of the family *Scutelleridae, Corimelaena extensa,* has been found of little importance also at Cedar Ranch, Arizona.

It is possible that in the course of time either by a developing habit or by an increasing abundance of any or all of these bugs, they may become very important pests of tobacco. At all events, the bugs may be controlled by the same remedies as recommended against the "suck fly."

The Bud worms (*Heliothis rhexia* S. *and* A. *Heliothis armiger* Hubn).—These are two distinct and rather similar insects known as bud worms, occurring frequently together in the same field.

The true bud worm, *Heliothis rhexia,* thus far, is found only to occur in the Southern States and the Tropics. The adult insect is a small greenish moth. Its caterpillar is nearly always found in the bud of the tobacco plants about the time of topping. They are usually late in their appearance, that is, they are most likely to be damaging toward the latter part of the tobacco season. The insect feeds on other plants, mostly of the nightshade or solanaceous group.

The false bud worm, *H. armiger,* sometimes called "fall worm" is not distinctly a tobacco insect, attacking the tobacco only when its favorite food plants are not abundant. The insect prefers cotton, tomato and corn especially.

The insect is rather variable, its worms varying from light green, without spot or stripe to nearly black in color. When attacking the tobacco plant, the buds are the principal parts damaged although the leaves are also eaten to a certain extent.

The arsenical spray recommended for flea-beetles is applicable to the control of these bud worms but in Florida, Prof. Quaintance recommends the sprinkling in the bud of a thoroughly mixed fairly finely ground corn meal (a quart) and Paris green ($\frac{1}{2}$ teaspoonful). Clean culture, careful attention to corn and tomatoes growing in the vicinity and late fall plowing to break the little earthen pupae cells of the insects are recommended.

Other tobacco leaf and stem feeders.—The so-called cabbage looper, *Autographa brassicae* Riley, is a noctuid moth which in the larval stage feeds chiefly on cabbage and related plants but has been found in Maryland tobacco fields, although not in sufficient number to make it important. The particular species is readily destroyed by the arsenical spray.

Mamestra legitisnea is an insect which is allied to the cutworms and feeds exposed upon the foliage of different plants. Its larva is a very handsome caterpilar, bright yellow in color, with velvety-black longitudinal lines. Thus far it has only been observed as a tobacco insect in southern Virginia. It is also easily destroyed by the arsenical spray.

The tobacco thrips (*Thrips tabaci* Lindemann).—This minute insect is primarily an onion pest, and attacks the tobacco in Europe. Recently there has appeared in Florida, Georgia, and Texas another species of thrips (*Euthrips nicotianae* Hinds), which according to Hooker of the U. S. Department of Agriculture Bureau of Entomology does much damage to shade grown cigar wrapper tobacco by sucking out the sap from the veins on the upper surface of the leaf, giving the veins and veinlets a whitish color which shows in the cured tobacco. Hooker recommends clean cultivation of the field between crops and spraying the plants twice a week, beginning while they are in the seed beds.

The "White Fly" of tobacco (*Aleyrodes tabaci* Germadices).—One of the insects especially noticeable in Europe is a minute form which looks like a small scale insect on the under side of the leaf. The species found in the United States (*Aleyrodes vaporiarum* Westwood) has not been observed definitely in tobacco fields but because it has always been found to attack tobacco in experimental plots, it is very probable that sooner or later it will be found in the fields too. The larvæ are nearly white or yellow and are attached to the leaf like scale insects. Spraying the under surface of the leaves with soap and water (one pound in eight gallons) should be given in order to destroy those which hatch from the egg after the previous application.

Plant lice (*Nectarophora tabaci*).—Green plant-lice are occasionally found on the under side of the leaves, especially the terminal leaves, although in Connecticut they have been observed on the older leaves. These insects do little damage, however. A spray of one pound of laundry soap dissolved in eight gallons of water should kill the lice. Nicotine sulphate is more effective.

The Mealy bug (*Dactylopius citiri* Risso).—The common mealy-bug has been observed in green houses, at Washington, D. C., to thrive and multiply alarmingly upon tobacco plants. It has not been recorded thus far, however, in open fields.

The Twelve-Spotted Driabotica or "Corn root Worm" (*Driabotica 12-punctata* Fabr.).—This insect is commonly found on tobacco in Connecticut, and injures it slightly by boring small holes in the leaves. It is also observed in Kentucky. It is not a dangerous tobacco insect, however.

Slugs (*Limax campestris* Binney) *and allied species*).—Plants in seed beds and sometimes recently transplanted seedlings are occasionally damaged by slugs; here arsenical poison can easily be used.

The Tarnished plant bug (*Lygus pratensis* Linn).—This insect has been found on tobacco in Connecticut and is thought to do more or less injury. Thus far, however, nothing very definite regarding the economic importance of the insects as a tobacco pest, has been established.

The Tobacco stalk weevil or Pith worm (*Trichobaris mucorea* Lee).—This beetle tunnels in the leaf stalks and in the main stem, often going down into the root. It is closely related to the corculionid potato stalks weevil (*T. trinotata Say.*). A soon as the crop showing the presence of this pest is harvested, all the stalk and rubbish should be burned.

"Stalk borers" (*Papaipema nitela* Guen).—This is another insect which may attack tobacco. It tunnels in the pith of the stems of potatoes, tomatoes, and other garden crops. Its adult is a mouse colored moth. Evidence of the pests should prompt clean cultivation and removal and burning of old stalks.

Tenebrionid beetle (*Opatum intermidium*).—This insect is not yet found in the United States but it is considered as a true tobacco pest in Russia, attacking the stems underground.

There is still a considerable number of insects observed on tobacco in the field that are not mentioned in this chapter, but they are of so very little importance as to be hardly worthy of the growers' attention.

The cigarette beetle (*Lasioderma serricorne* Fabr.).—Stored tobacco, cigars, and cigarettes are frequently attacked by insects and injured to a greater or less extent. The chief depredator is a small bettle of the family *Ptinidae,* bearing the Latin name *L. serricorme* Fabr. This beetle breeds in tobacco and many other dried vegetable products. The adults bore their way out,

leaving small round holes. This, of course ruins cigars and cigarettes, or, if leaf tobacco is attacked, spoils it for wrapping purposes, and its value diminishes. Fumigating with carbon bisulphide, or steaming the tobacco, will destroy the insect in all its stages.

In fumigating with bisulphide, every precaution should be taken to see that the room is perfectly air-tight, and also that no fire is allowed to enter the room until it has been most thoroughly aired. The vapor of carbon bisulphide in confinement is inflammable and explosive. One ounce of the liquid should be evaporated for every 62½ cubic feet of space, or one pound for every 1,000 cubic feet.

Cellophane wrappers have contributed much recently in protecting cigars and other manufactured tobacco products from the beetle.

Of particular interest is the fact that a little four-winged fly (*Catolaceous anthonomi* Ashmead) is parasitic on the cigarette beetle, laying its eggs in the larva of the beetle. While the parasitic work of the fly is not very great, it nevertheless keeps in check the rapid multiplication of the pest.

Other beetles known occasionally to infest dried tobacco are, the drug store beetle (*Sitodrepa panicea* Linn), the leather beetle (*Dermestes vulpissus* Fabr.) and the rice weevil (*Calandra oryza* Linn). Remedies are the same as for the cigarette beetle.

TOBACCO DISEASES

Damping off (*Rrizoctonia solani, Phythophora nicotiana, Sclerotium rolfsii and Pythium debaryanum*).—Damping off is a disease in the plant beds commonly caused by four fungi of the genera *Pythium, Phythophthora, Sclerotium* and *Rhizoctonia.* The symptoms of these two diseases are identical, but upon microscopic examination the difference can be easily determined in that the mycelium of *Phythium debaryanum* is nonseptate while that of *Rhizoctonia solani* is septate. Wet soils, abundance of organic matter, high humidity and poor ventilation of seed beds, are the principal factors that favor damping off diseases. The disease can be avoided by sparse seeding and by utilizing new land for seed bed purposes. If old lands are used for seed beds they should be thoroughly sterilized. A good drainage is an essential factor that should not be overlooked. The shed of the plot beds should be removed occasionally during good weather

and the beds should be watered thoroughly but not too frequently. If only patches are infected, these spots should be scraped (seedlings and soil) and the areas sprayed with 1:50 formaldehyde solution.

Seedling stem rot.—While the general effect on the seedlings of the fungus causing seedling stem rot, is the same as damping off, the causal organism, however, is entirely different, because of the presence of white fungus threads creeping over the decayed plants. The remedies are the same as the means employed against the damping-off trouble.

Root-rot (*Thielavia basicola* (B & Br.) Zapf.).—Root-rot is another fungus disease causing rotting of seedlings in the beds and poor stand of plants in the field. This disease is limited to the root system so that symptoms above ground are marked by stunted growth and chlorotic appearance. Generally the symptoms above ground resemble those caused by food deficiency. The only way to distinguish the root rot is to examine the root system of the plants. As this disease can stay in the ground for a considerable length of time it is best to practice rotation in highly infected ground. Low soil temperature favors the occurrence of root rot. Root rot in seedbeds can be avoided by using new land for seed plots, or, if old lands are used, they should be thoroughly sterilized. The transplanting of seedlings that are infected with root rot should be avoided, and if sufficient ground is available, heavily infected ground should be fallowed for at least two or three years. The planting of resistant varieties cannot be over emphasized.

Sumatra disease (*bacterial*).—This trouble appeared on Sumatra plants in Connecticut in 1907 and caused severe injury. The disease is different from damping off troubles and root rot because the injury includes the base of the stem and the root immediately below it. It has not been seen yet on the variety Havana or Broadleaf. While the disease has not as yet been definitely identified, actual available evidences seem to show that it is bacterial. It is easily checked by breeding for resistant tobacco varieties or strains.

Canker (*bacterial*).—Canker shows as a girdling of the stem underground of a diseased area on the stem above. In the latter case there is a dark brown sunken area in the bark, sharply marked off from the healthy green bark. While other diseases or even insect injuries may be the starting point of the disease,

the canker itself is probably of bacterial origin. Till now it has not been common enough to do serious damage. Heavy manuring seems to favor the development of this disease.

Mosaic or calico.—The mosaic disease is characterized by crinkling and by the molted condition of the leaves. The diseased areas either appear lighter or dark in color than the healthy portion and are rough to the touch. The causal organism is so far not known and it has never been possible to demostrate the presence of either bacteria or fungus in the tissues of any part of the affected plant. Until more is known about the action of the so-called "ultramicroscopic" organisms, the disease cannot be ascribed to an organism of that class, as the character and reactions of the causal agent do not in any respect coincide with the reactions of that class of organisms. Many of the reactions of the causal agent are of such nature as to indicate that it is either an enzyme, an aggregate of enzymes, or the product of enzyme activities.

While the disease is not contagious, it is very infectious, particularly when inoculated into young plants. On fields, the infection can be usually traced to the seed bed. Infection is usually effected by careless handling of the seedlings during pulling and transplanting and in worming. It is estimated that about 80 per cent of infections occur in this manner.

Owing to the nature of the disease the matter of absolute prevention and control is difficult, but with careful attention to details of sterilization of the seed bed and handling of the seedlings at transplanting and worming time, a large percentage of infection can be avoided. The hands should always be washed after touching calicoed plants, and in worming separate workers or worm pickers should be assigned to pick worms only on affected plants. Mosaic or calico appears on plants of any stage, young and old alike, but the disease seems to be more ravaging when the plants are about to flower.

Frenching (*nutritional deficiency*).—The frenching disease is frequently confused with mosaic and at times both are considered as one and the same thing. This confusion is due to the identical symptoms exhibited by affected plants during the early stage of either disease. The early signs of the appearance of frenching is like the early stage of mosaic. It is only when the disease is approaching the severe stage that real frenching habits are manifested. Plants attacked by frenching are weak and very brittle. The leaves of plants attacked severely with french-

ing become narrow and ribbon-like. In many cases the leaf buds grown in bunches, are tooth-pick-like and stringy. The upper surface of the leaves shows yellow spots, and the leaves are thicker than normally. When this disease appears on the seed bed, the seedlings could hardly be recognized as tobacco seedlings, due to the stringy and tooth-pick-like leaves and almost without any visible internodes.

The disease may appear at any stage of the development of the plants and oftentimes occurs when the plants are at the flowering and suckering stages. This disease is not infectious and therefore, is not a germ disease but is due to malnutrition. Deficiency of nitrogen in the soil, defective drainage, wet soil and poor cultivation are the factors that may bring about the occurrence of frenching. This disease was successfully controlled in La Union Province, by the application of nitrogenous fertilizers. This disease has been the subject of intensive investigations in the United States and was found to be due to nitrogen soil deficiency. It was observed that under Isabela conditions disease seedlings when grown in rich alluvial soils grow into normal plants even without fertilizer application. The plant affected recovers because the frenched leaves do not become normal but as the plant grows the subsequent leaves develop into normal ones and when the plant has become big enough the disease is absolutely without any trace. Highly inclined grounds when not properly terraced to prevent soil washing due to heavy rain are likely to produce frenched seedlings. Old land for seed beds must be adequately fertilized and if the disease occurs among the plants in the field the application of nitrogenous fertilizer is inevitable. This disease occurs both in the shade and in the open culture.

Nematode or root knot (*Heterodera radicola*).—Root knot is caused by a minute eelworm or nematode which bores into the roots. These little worms scarcely visible to the naked eye, cause the roots to develop characteristic hypertrophies or galls varying greatly in size. This disease, therefore, is very easily recognized by examining the root system. Plants heavily affected with root galls are stunted in growth and appear chlorotic. Seedlings with root galls should not be planted and fields severely infected should either be fallowed or planted with other crops for at least two or three years before it can be planted again to tobacco.

Bacterial (Granville) and Fusarium wilt.—The causal organism of bacterial wilt is *Bacterium solanacearum* E. F. S. while that of Fusarium wilt is *Fusarium* sp. Both diseases attack the root system of tobacco and other members of the nightshade family like potatoes, tomatoes, eggplants, etc. It is hard to determine the differences between these two diseases if judgment is based only upon external appearance of affected plants because the symptoms are the same. The only way to determine whether the disease is either bacterial or fusarium is to examine the roots and stems of a diseased plant. When the stem or root system is halved longitudinally and the section upon being pressed between the fingers oozes out slimy liquid that is somewhat putrid in odor then the disease is bacterial. Otherwise the disease is fusarium. The fusarium wilt infection seems to be favored with the increase of temperature while the bacterial wilt acts more favorably when the weather is moist and cool. Early planting escapes the fusarium wilt a great deal but at the same time suffers from the bacterial wilt if both diseases are present in the same soil. It is a very unfortunate fact that in the Philippines both diseases occur in the principal wrapper tobacco regions. The bacterial wilt is severe in Laguna while the fusarium has ridden the wrapper district of La Union. Crop rotation should be a good practice, the tobacco rotated with legumes after every five to seven years. The development of resistant varieties while not an immediate remedy will in the long run be a more stable and effective method of minimizing the ravages of these diseases. It has been found after two years trial that under La Union conditions, severe fusarium wilt infection can be checked very successfully by erecting shelter tents over the plantation. This finding simply correlates the observatoin of other workers that the fusarium wilt infection increases as the temperature increases and vice versa. It may be stated here that the growing of wrapper tobacco by shading in La Union Province has come about as an expedient remedy against the fusarium wilt as in doing so the disease is not only placed under control but at the same time the resulting crop is a more valuable crop than the ordinary cigar filler which was then the regular crop of the La Union tobacco plantations. Fusarium and bacterial wilt diseases attack tobacco plants in all stages. In mild cases one or two leaves show sign of wilting and as the plant becomes exhausted it gradually wilts and dies. In severe infection the whole plant

suddenly wilts and in a couple of days dies. When only few plants are affected in a plantation, these should be pulled and burned to at least check the spread of the disease, but when the infection is very severe even this pulling and burning of dead plants do not help very materially.

Hollow stalk.—This disease is a decay of the pith of the stalk, sometimes extending out into the midrib and veins of the leaves, causing them to drop. The decay may start from the base of the stalk, or at the top of the plant through injuries produced by topping or suckering. The disease has been shown to be apparently of a bacterial nature. Johnson of the Wisconsin Experiment Station claims that a bacillus of the soft rot type has been isolated by inoculating healthy plants. As a means of controling the disease, all affected plants should be removed from the field. Persons topping or suckering may carry the disease from diseased plants to healthy ones, which under moist conditions or weather, decay rapidly.

Tobacco injury due to malnutrition or over-fertilization.—At the Massachusetts Agricultural Experiment Station, a root injury to the plants which is manifest a week after transplanting resulting in differences in growth, has been observed. Dr. G. E. Stone of the Station claimed that the trouble is due to over-fertilization, the roots (especially the tap root) having all the characteristic symptoms of fertilizer burning—that the absence of fungi is an indication of some abnormal soil condition being responsible for the trouble. The final conclusions reached were that the combined effect of the total soluble mineral constituents (water soluble salines) in the soil is responsible for the injurious effect on the growing plants rather than an accumulation of any one of the soluble elements. This assertion at least agrees with Pfeffer's statement to the effect that "the concentration of the cultural fluid is always important, for when its osmotic concentration passes a certain limit, growth becomes impossible, though no poisonous effect is exercised. While when the fluid is too dilute, or when a single essential salt is present in insufficient amount, the development of the plant is retarded."

There are two ways pointed out to remedy the injury, crop rotation (including corn) and underdrainage. In either case the idea is to reduce the concentration of water soluble salts or mineral constituents in the soil.

Sore shank.—In this disease the stalk undergoes a decay at the surface of the ground and the plant finally topples over. The

plants, as a rule make a normal growth and there may be no indications of disease until the plant suddenly withers and dies or, perhaps, falls over from the effect of wind. Generally, damage from this disease is small since only a plant here and there over the field is affected. Occasionally this disease may cause a peculiar wilting and dying of the lower leaves, perhaps only the portion of the leaf on one side of the midrib being affected. This disease is caused by a fungus which attacks the stalk of the plant at or near the surface of the ground. No definite remedy is known but rotation of crops will probably be found beneficial.

A new bacterial leaf disease of tobacco.—This disease was first observed in the Cagayan Valley and reported in 1930. It is characterized by white or opaque spots. Tobacco seedlings may become destroyed entirely or rendered useless for planting by the disease. The causal organism of the disease is a bacterium called *Phytomonas polycolor* Clara.

So far the damage by the disease have been minimized by disinfection with silver nitrate 1–1,000 for 10 to 15 minutes. This means of control serves to destroy other organisms that are seed-borne as for example those called wild fire and angular leaf spot.

Tobacco wild fire (*Bacterium tabacum* Wolf and Foster).—The disease is so named principally because it appears so quickly and spreads so rapidly as to seriously affect the leaves. The first evidence of the disease which is due to bacteria, is the appearance of characteristic circular areas. The spots develop into larger size with a border of water soaked appearance marking the margin of necrotic tissues. Finally when the spots are numerous, they fuse causing larger irregular areas of leaf tissue to become dry.

Frog-eye (*Cercospora nicotianae E & E and other fungi*).—This leaf-spot disease appears circular, and brown with a darker order and with grayish centers as compared with wildfire spots. Upon the gray centers may be seen the fructifications of *Cercospora nicotianae* or other fungi thus far undetermined.

Specks.—Specks may be tan-colored or whitish. The whitish speck may be mainly due to a fungus (*Macrosporium tabacinum*). Specks resulting from a deficiency of potash, appear as tan colored, irregular areas which are first present at a distance from the principal veins. When this disease is accom-

panied by chlorosis there is no definite hole around the region. In the case of frog-eye and specks the margin of the affected tissues does not disintegrate and fall out as with wildfire.

Green-leaf spot.—The green spot disease of tobacco is a serious handicap in the production of wrapper tobacco. Considerable attention was attracted by its prevalence in Sarunayan, Cotabato in 1927. Since then it has remained a serious problem. The harvests from this region were rejected by cigar manufacturers because of the presence of the green spots. The disease renders the crop unfit for wrapping high grade cigars.

From an investigation of the disease conducted since the early part of last year, it appears that the disease may be controlled by treating the leaves with 5–10 per cent solutions of Acetic acid. With this treatment the green spots disappear from cured leaves without any apparent injury to the quality of the wrappers. Other very beneficial effects derived from the treatment are the retention of the desirable texture, pliability, color of the leaves and the prevention of the active growth of molds frequently encountered on tobacco leaves. Treated leaves under observation for nearly a year now, have not shown any untoward effects upon the quality. Other treatments used did not give as good results, and some gave entirely negative results.

From the studies on the possible causes of the disease, a fungus very similar to *Botrytis* was isolated from the green spots. Artificial inoculations on potted plants and harvested leaves reproduced the disease typically and readily on the latter under very moist conditions, while on the former, two kinds of spots, brown and green were produced.

The green-leaf spot is apparently influenced by altered weather factors brought about by shading. Laboratory tests confirmed the presence of abundant green pigment and starch in the spot. This spot malady is never noticeable in the field and therefore is very deceiving. It begins to manifest itself when the leaves begin to cure, the spots drying very much faster than the remaining portion of the leaf. Open grown wrapper is seldom affected by the green spot. As its name indicates, the spot is deep green in color on cured leaf, very brittle, and feels rough to the touch. The spot, however, becomes lighter in color in fermented leaves. This green spot malady can possibly be gotten rid off in the field by using thinner shade and by erecting shelter tent higher than six feet in order to give more air to the shaded plants.

In general the factors concerned in bringing about the outbreaks of leaf-spot diseases are weather conditions, maturity of leaf upon harvest, and soil fertility. Under exceptional conditions the diseases may appear at any stage from the seed beds till after the tobacco has been placed in the curing barn, but ordinarily the plant is only seriously attacked when the leaf is almost, if not quite, ripe. Again, leaf spot is never serious except as a result of wet weather. Dark shipping tobacco grown on heavy soils and topped lower is more susceptible to spotting than tobacco grown on lighter soils and topped higher. Potash in the fertilizer is of some value in reducing injury from leaf spot, but cannot be relied upon for this purpose unless supplemented by other measures; namely, the avoidance of too much ammonia in the soil or in the fertilizer and making sure that the tobacco is not topped too low. These are the only practicable measures now available for reducing the danger from leaf-spot diseases.

Orobanche ramosa L., *a parasitic plant.*—This is a flowering plant suspected in Cuba to be parasitic on the roots of tobacco. It usually stands close to the tobacco stumps, or it may be at a distance of two to three decimeters. It is generally a cluster of stalks, one to four decimeters tall, without leaves, yellowish white in color, and bearing flowers and seed pods which somewhat resemble those of tobacco. The roots of the parasite form a thick cluster and attach themselves closely to the small roots of tobacco. In Cuba, wherever the parasite occurs, it is pulled and burned.

Lightning injury.—Lightning may also injure tobacco as reported in the 1915 Report of the Connecticut Agricultural Experiment Station (New Haven). An injured plant will have one leaf shrivel up and soon another on the same side of the plant, then the whole top will wilt and die. A patch as big as one rod in diameter may be affected. Injuries, if they occur, usually follow a thunderstorm and is especially distinguished from other injuries by the fact that the affectation does not spread.

Frost fungus.—This disease appears on the leaf stems in the barn, at first in pure white patches looking like hoar frost or velvet. The patches spread to the leaf veins, destroy the tissues and decay follows. The white patches are the fruiting stage of the fungus. Its spores are developed and carried over to the next year in the stalks and waste leaves left in the barn. This mold may be prevented by perfect cleanliness in the barn from

which all stalks and waste should at once be removed. In extreme cases the floor should be covered with fresh earth or sprinkled with a mixture of slaked lime and sulphur, or the barn fumigated.

Stem rot and pole burn.—These troubles are caused principally by the growth of a fungus on the leaf in the curing barn. The fungus by destroying the tissue gives access to bacteria which induce decay. In Wisconsin, however, where the occurrence of the trouble prevails, it is credited mainly to fungi of a saprophytic nature (a species of Fusarium being the most common cause). The difference between shed burn and stem rot appears to be primarily one of location, rather than a difference in the causal organism. If the fungi attack the midrib the result is stem rot, and if the leaf tissue is attacked, the decay is called shed or pole burn. In controlling the disease, growers must rely upon regulation of temperature and humidity of the curing shed by proper ventilation, or the application of artificial heat. More than 80 per cent relative humidity in the curing barn is the danger signal while beginning at 85 per cent, the barn must be heated.

Black spot or Black rot.—This warehouse trouble appears in the leaves after these have been packed in cases for fermentation. Canker is apparently a fungus trouble in which dark colored patches are produced that often extend down through the leaves of several overlapping bands. The injured tissues are dark colored, become brittle and easily fall to pieces. Microscopic examination reveals the presence of abundant but isolated purplish black spores, apparently those of *Sterimatocystis niger*. It is not known just what conditions favor the development of this trouble, whose presence is not known until the cases are opened for examination. Probably too much moisture favors its development, especially if care has not been used in selecting and packing the tobacco.

Mold of cigars (*Must*).—Must is a fungus or bacterial trouble also developed in the packed tobacco and is named from its musty odor. Examinations of specimens show the presence of a slight whitish growth, especially along the midribs. Numerous bacteria and also some molds are found in these growths. Cultures from a specimen placed in a damp chamber produced a reddish brown mold. Dealers sometimes renovate musty tobacco by washing the leaves with rum and by sterilization with steam. Musty cigars and cigarettes are also minimized by the use of

disinfectants in pastes and the employment of tragacanth gum exclusively.

The most common species of molds found in cigars is *Aspergillus candidus*. *Penicillium glaucum* is also prevalent.

IX. CIGAR MANUFACTURE AND UTILIZATION OF WRAPPERS

Cigars are either rolled by hands or by machine. The manufacture of cigars by machinery is now carried on extensively in the United States and in other countries. In the Philippines, the dainty fingers of the Filipina women perform with concise accuracy the work of the cigar machine. As to which of these methods is more convenient and profitable depends upon existing local conditions. While the cigar-rolling machines are profitable in America and in some European countries, this is not the case in the Philippines, and the rolling of cigars by human hands still continues to be the sole method of cigar manufacture.

Manipulation and handling of leaf tobacco preparatory to cigar manufacture.—As stated in a previous chapter, there are three distinct products of tobacco for cigar manufacture: namely; the filler, the binder, and the wrapper. The filler constitutes the main body of the cigar; the binder holds the filler bunch and keeps it in shape before it is finally enveloped by or rolled into the wrapper leaf.

As a general rule, cigar leaf tobacco (filler, binder, wrapper) must first be completely and properly fermented and aged for a period of at least two years before it can be utilized for cigar manufacture. As a matter of fact, the wholesomeness of a cigar depends upon the length of time the materials are aged; the older the materials the better is the quality of the cigar.

Let us assume that a factory is to start work on cigar manufacturing. The bales of tobacco are opened and the blending according to the factory's secret formula is effected. It may be one-to-one Cuban-Connecticut blend; it may be one-one-to-one Cagayan-Isabela-La Union blend; it may be one-to-two Partidos-Vuelta Abajo blend; etc. The leaf tobacco is then subjected to steam sterilization in a vacuum sterilization machine for a period of at least 24 hours to kill all possible organisms that are likely to destroy the finished cigars. After sterilization, the leaves are plunged into a tank of water to be washed and the excess of moisture is drained off. When the tobacco is in the proper degree of pliability it is conveyed to the stripping room where the midribs are removed. In the case of fillers and bind-

ers, the midribs are removed by hand, while wrappers are stripped either by the stripping and booking machines or by hand. The stripped tobacco is next scattered about on a spacious floor or on racks to effect further drying until it is in good order, after which the materials are piled in heaps to complete the fermentation. Fermentation usually takes place in 40 to 60 days, the pile being destroyed and rebuilt regularly to effect an even and thorough fermentation. In cases where the tobacco is an unusually old crop, this fermentation process is generally omitted. The crop is then ready for cigar manufacture.

CIGAR MANUFACTURE AND HAND ROLLING

The cigar maker sits in front of a table that is provided with a trough for waste and a rack for holding the rolled cigars. He is provided with a flat knife for cutting the wrapper to the required shape and size and for evening the length of the cigars. On one side of the table are bunches of filler and binder piled separately and on the other side is the pad or book of wrappers covered with a damp cloth. Just in front of him is a rectangular piece of hard wood on which he rolls the cigar, and besides this wood is a cup of gum tragacanth, usually of the same color as that of the wrapper leaf, for pasting the tip of the cigar. As a rule, only one size and shape of cigar is assigned to each cigar roller. In this way every individual worker becomes expert in the rolling of a specific shape of cigars.

The workman takes a sufficient quantity of filler, arranges it longitudinally, binds it with the binder leaf to form the required shape, and winds the wrapper that has already been cut and trimmed spirally around the cigars beginning at the tuck end. The wrapper is secured either by pasting the entire wrapper blade or by simply gluing the blunt end of the cigar. High grade cigars have only their blunt point pasted, while cheap cigars and cheroots generally have their wrappers pasted throughout the length of the cigar. The cigar is then smoothed to roundness by the flat knife as a finishing touch and afterwards placed on the rack. Cigar rollers become so expert that the size, body, shape, length, and evenness of the cigars are always uniform. As the finished cigars accumulate, they are bundled by 50's or 100's and turned over to a foreman. A Filipino cigar maker can roll as many as 150 to 400 cigars a day, depending upon the size, shape, and style of the brand assigned to him. Both men and women are employed in cigar making.

Classification and sorting of cigar.—The foreman of the cigar rollers delivers the bundled cigars to the man in charge of the sorting and classification rooms or "escogidas" where the cigars are sorted and classified according to color, size, shape, and finish. All cigars not coming up to the standard are separated and discarded. Cigar sorting is therefore mainly dependent upon the wrapper.

Sterilization of cigars.—The cigars, after thorough sorting and classification, are next brought to the vacuum chamber, packed in temporary boxes, and subjected to high heat to make sure that any remaining organisms or insects destructive to the cigars are killed. This treatment lasts for 24 hours, after which the cigars are conveyed to the banding and boxing or packing rooms.

Banding, wrapping, and packing of cigars.—Most brands, before they are incased, are banded with beautiful paper rings bearing the name of shape, brand and the factory, and wrapped singly or collectively with tissue paper, tin foil or cellophane (now universally used because of its transparency and durability). This done, the cigars are packed into fine cigar boxes made of wood, metal, or pasteboard. The number of cigars in a box varies from 10 to as many as 500 or even 1,000. The packing of cigars by the hundreds in expensive cigar cabinets and other fancy containers is done only for orders coming from high personages, like kings, emperors, princes, statesmen, etc. Expensive cigars for retail are as a rule packed in small quantities, generally not more than 50 in a box. The more common number, however, is 25 cigars to a box. In rare cases, a one-peso or one-dollar cigar is packed singly. The boxes are nailed and sealed at the edges with fancy strips of paper or cloth, labeled, branded, and stamped—ready for immediate shipment to retail jobber or for storage.

CIGAR MANUFACTURE BY MACHINERY

Automatic machines for the manufacture of cigars have been perfected during the last ten years, and these inventions led to a revolution of the cigar manufacturing industry in the United States and other countries. About fifteen years ago, cigar machines made their appearance that, in a single series of uninterrupted operations, weigh and bunch the filler, roll it on the binder, and deliver the bunch to a wrapping station where the cigar is finally wrapped with the wrapper leaf, then convey

it automatically to the inspection table as a complete cigar. In fact, all operations from blending, steaming, washing, drying to banding, packing, or boxing are done mechanically. There are various makes of cigar-making machines on the market, but the principles or mechanism of their operations are practically the same. A modern machine has an output of 20,000 to 30,000 cigars weekly. These machines are designed to make cigars of any size and shape, and to use any kind of leaf tobacco as materials. A cutting station weighs, measures, and feeds the required filler to form the bunch, transfers it to a rolling belt where it is wrapped by the binder, thus forming the bunch. The bunch is next rolled, softened, and crimped through a series of belts, girding plates, and gears, after which it is conveyed to the wrapping, re-rolling, and trimming divisions. The finished cigars proceed next to the sorting and classification divisions where they are sorted and classified as to color and size by an automatic cigar sorting machine operated by electricity. The so-called "eye" of the machine is a photo-electric cell similar to that used by astronomers in determining the intensity of the light of stars. This cell generates electricity proportional to the intensity of light that strikes it. Cigars of light color reflect more light than cigars of darker color. The cigars, having been sorted and classified, are next transported to the banding and packing machines where they are banded and packed into cigar wooden boxes, metal cases, or card-board containers. Cigar boxes and other containers are also made by machines. Even the branding and stamping of the boxes are mechanical operations. Among the important machineries employed in cigar manufacture are the stripping and booking machines, the bunch-making and the cleaning machines, the stamping machines, the cellophane wrapping machines, the banding and packing machines, and the cigar-box-making machines.

COLOR, SHAPES, BRANDS, AND BOXES OF CIGARS

Commercially the colors of cigars are designted as *claro* (very light brown), *colorado claro* (light brown) *colorado* (brown), *colorado maduro* (dark brown), and *maduro* (dark). When the *maduro* color was still very popular, the *oscuro* (black) was also a standard color. In sorting and classifying the finished cigars, however, the manufacturer distinguishes as many as 100 shades of the above five standard colors. This phase of the work, of separating all shades of a single color, is very important, because

it renders possible a uniformity of color of the cigars in a box, thereby satisfying the whims of the most critical smoker. The only colors, however, used as trade marks on cigar boxes are the five colors mentioned above; these alone are known to the public and recognized by smokers. The rôle of wrappers is obvious as regards cigar colors.

The nomenclature of the numerous shapes and brands of cigars is very extensive and several factories name some of their products after famous men of history, famous places, and even deceased managers of their firms. Invariably the name of the factory is the main brand. Among the popular shapes of the present are the *Presidentes, Vice Presidentes, Excelentes, Especiales, Conchas, Perlas, Perfectos, Divinos, Imperiales, Incomparables, Esmeraldas, Predilectos, Londres, Invincibles, Coronas, Brevas, Damas, Panatelas* and *Regalias*. Each brand as a rule includes several sizes, shapes, and colors. Fashion is full of vanity, so that in spite of the ceaseless attempts of manufacturers to standardize the shape, size, and color of their products, they can not do so because of the ever changing whims of smokers. There was a time when big black cigars were in demand. Soon after, the speckled type became so popular that some factories went to the extent of artificially causing spots on the wrapper. Later on *oscuros* were in great demand. The call for the present-day light *claro* cigar has been of fairly recent date. As to what type and color of cigars will be desired in the near future, only time can tell.

The kinds of wood generally used for cigar boxes are Spanish cedar (*Cedirela odorata*), Philippine Calantas (*Toona calantas*), Rosewood, and Mahogany. These are peculiarly adapted for cigar boxes because of their lasting aroma, which, when blended with the aroma of cigars, makes a pleasant wholesome combination, improving the quality of the cigar. Other cigar boxes are made of glass, fancy porcelain, and lithographed metals. Very low grade cigars are packed in card board packages or boxes. Cigar cabinets made of the finest wood are sometimes inlaid with jewels and enamels of great value. These splendid specimens of art have found their way into the art stores of Europe, commanding considerable prices.

X. TOBACCO BREEDING WITH SPECIAL REFERENCE TO WRAPPER PRODUCTION

The tobacco of commerce is known botanically as *Nicotiana tabacum* L. It was named after Jean Nicot who introduced the

plant into Europe from Portugal. There are approximately about 50 species of *Nicotiana,* some of which are subdivided into varieties. The tobacco of commerce (*N. tabacum,* Linn.) is a tall herbacieous annual plant reaching a height of from 1 to 3 meters. The leaves are lanceolate to elliptic-ovate, acuminate-pointed, sessile or petiolate and decurrent, and usually pubescent. The flowers are about 2 inches long, from almost white to pink, forming a large terminal and compound panicle. The calyx is green, 1 to 1.5 cm. long, enlarged in fruit. The corolla is narrow, funnel shaped, 5-lobed and about 5 cm. long. The capsule is 2-celled, ovoid, 1.5-2 cm. long with numerous small seeds. From earliest times the Indians in America cultivated it.

Strictly speaking, there are only four recognized wrapper tobacco varieties; namely, the *Sumatra, Cuban* (*Havanensis*), *Havana seedleaf* and the *Connecticut broadleaf.* To these can be added the Porto Rican and Philippine wrapper varieties: Simmaba, Vizcaya, and Ilagan Sumatra. These varieties have been fully described previously.

Varietal classification, especially with reference to wrapper and other cigar tobacco varieties, are based mainly on noticeable leaf differences and climatic and soil adaptations. There is no crop more susceptible to variation and deterioration than tobacco. The various types and varieties of tobacco now in existence are the result of continuous selection, hybridization and adaptation to meet the demands of manfucturers and consumers. This work for the preservation of existing good varieties, as well as the creation of new ones, is an endless task and requires the services of patient and tireless researchers.

INBREEDING

The properties of ideal wrapper tobacco have already been defined repeatedly in the preceding chapters. Before discussing the feasible methods whereby these ideals may be obtained, it is necessary to dwell for a moment upon the importance of inbreeding with reference to tobacco in general.

Tobacco plants are characteristic or typical examples of certain groups among the higher plants which are distinguished by more or less insured continuous self-fertilization. It is because of this fact that species and varieties of *Nicotiana* were used to advantage by investigators of sexuality and inheritance in plants even as early as 1776. Among the early investigators who worked on members of the genus *Nicotiana* are included

practically all the famous forerunners of the science now known as Genetics.

Starting with the universal saying that "like begets life," it is readily observable how important inbreeding must be. Experience has shown conclusively that seed from inbred or self-fertilized tobacco plants tends, if not altogether definitely, to produce a uniform progeny. Experience and experiments have also shown that seeds produced by self-fertilized tobacco plants are just as viable or as strong, if not stronger, than cross-bred seeds. However, as a result of the activities of flying insects going from one tobacco flower to another and from field to field, and possibly also through the agency of the wind, foreign pollen often find its way to desirable mother plants. It is advisable, therefore, to resort to a means whereby self-fertilization is absolutely insured. The flowers must be bagged. Bagging is a simple operation. Patented paraffine or manila paper bags may be used. Too heavy a covering would bend the flower cluster to an unnatural position, adversely affecting the development of the seed. For this reason, it is well to place a strong stake close beside the plant and to tie the paper bag to this. In humid regions cheese-cloth bags are preferable as they can stand being wet better than paper.

From 12 to 15 days after the pods are formed, the bags can be removed and the seed allowed to develop and mature in the open; care should be taken that all the young buds are pruned, to make sure that only self-fertilized seed is obtained. When the seed pods show signs of maturity, the flower clusters should be cut off and hung up to dry for some time in a well protected place, preferably in a curing shed where there is no chance of their getting wet; when thoroughly dry, the seed should be threshed, cleaned, and stored in air-tight bottles or jars with a few tablespoonfuls of flaked naphthalene to protect it from seed-eating insects.

Detail study of the tobacco flower.—For a better realization of the case with which tobacco plants are self-fertilized and of the possibility of cross-fertilization, the following study on the structure and arrangement of tobacco flowers from "Tobacco Breeding" by Shamel and Cobey, U. S. Department of Agriculture, Plant Industry Bulletin 96, is hereby given:

> The tobacco flowers are arranged upon a branching determinate flower head, which appears when the middle leaves are about half grown and continue to develop and produce new flowers during the rest of the life of the plant. Fig. 6 is a sketch of a longitudinal cross section of a tobacco

flower, showing the parts of the flower and the general way in which pollination takes place. The calyx (A) is the outer green five-parted, floral envelope at the base of the flower which serves to protect the flower bud. The corolla (B) is the delicately colored floral envelope inclosing the reproductive organs of the flower. Its color tends to attract insects, which are the principal agents in cross pollination. Next inside the corolla are the five staments which are the male reproductive organs of the flower. Each stamen consists of the filament (I) supporting the anther (J) in which the pollen grains (K) are produced. The central organ is the pistil, or female part of the flower. The terminal enlarged portion (G) is the stigma. The pollen grains (K) adhere to the surface of the sigma and germinate, sending an extremely minute tube (E) down through the central conductive tissue (H) of the style (F). This tube extends into the cavity of the ovary (D) and finds its way into the ovule (N) through a small duct or micropyle (M) where fertilization takes place. Other ovules are fertilized by other pollen tubes. These ovules develop into seeds after fertilization. The ovary is two-celled with a fleshy central placenta (C) on which the ovules are borne. The early capsules mature always before flowering ceases. The shape of the delicately colored corrola is somewhat tubular, or, perhaps, more nearly like an elongated funnel. It is comparatively small from the basal end to a point about two-thirds the distance to the terminal end of the flower. At this point it enlarges suddenly to more than twice the size of the basal part of the tube. It is composed of five petals, which coalesce to form the corolla tube and separate only at the extreme end. The tobacco flower is symmetrical. The number of sepals and stamens is always the same as the number of petals, but the floral circles do not remain constant, varying rather indefinitely in different strains and even among individuals of the same strain. Trimerous flowers or flowers with three parts in each flower circle, have been found growing in the same plants with pentamerous flowers or those having five floral parts. This is the exception, however, and not the rule.

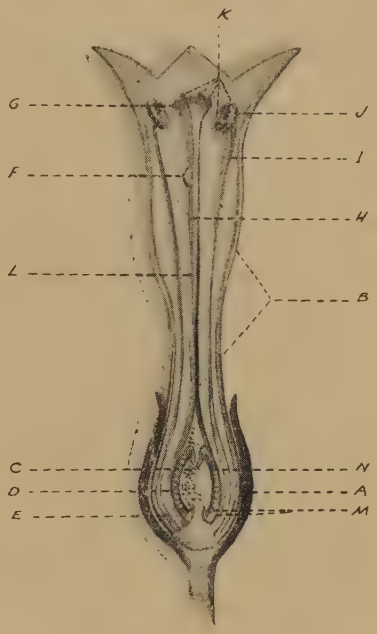

FIG. 6. Diagram of a tobacco flower (longitudinal section).

A very interesting phenomenon occurs in the filaments of the stamens immediately after the opening of the flower. Just before the opening the pistil is longer and extends up beyond the stamens, but when the anthers open and the stigma becomes receptive, a very rapid growth of the fila-

ments takes place, which causes the open pollen sacks to be pushed up past the stigma, and in almost all cases they come in direct contact with the stigma in passing upward. This gives an opportunity for at least a portion of the pollen grains to adhere to the viscous surface of the stigma for self-fertilization to take place as already described. It is just before this process occurs or while it is in progress that there is danger of, and opportunity for, cross-pollination. The open flower contains a small drop of nectar at the base of the corrola tube which is sought by honey bees, bumblebees, and humming birds as well as by many species of minute insects, all of which carry pollen from flower to flower and from plant to plant in their constant search for the honey-like substance secreted in the corrola tube. In passing in and out of the flowers the bodies of the bees and other insects and the beaks of the humming birds become dusted with pollen, which is transported by them to the pistil of the next flower visited. The ovules are readily fertilized by pollen from the surrounding plants as by the pollen from the flower in which they are produced. This continuous crossing necessarily results in the introduction and intermixture of poor and undesirable varieties in our best strains of tobacco.

Variation.—For a better understanding of the primary importance of selection in the production of wrapper tobacco, it should be made plain that under ordinary conditions, tobacco everywhere, while it admits of easy inbreeding, is a variable plant. If one should study the variability of a field of wrapper, he will observe at least the following characters in greater or lesser variation.

1. Height
2. Number of leaves
    - (*a*) Number of sand leaves
    - (*b*) Number of standard leaves
    - (*c*) Number of top leaves
3. Dimensions of leaves and character of petiole
    - (*a*) First lowest standard
    - (*b*) Last upper standard
4. Form or shape of middle standard
5. Texture
    - (*a*) Pubescence
    - (*b*) Gumminess
6. Color of leaf
    - (*a*) Dark green
    - (*b*) Green
    - (*c*) Light green
7. Charactter of leaf surface
    - (*a*) Hairy
    - (*b*) Smooth or oily
    - (*c*) Wavey

8. Position of leaf on stem
   (*a*) Horizonal
   (*b*) Erect
   (*c*) Drooping
9. Length of internodes
10. Branching habits
11. Flowering habits—cluster form
12. Possibly disease resistance

In recording the number of the leaves per plant one or two dead bottom leaves must be discarded. The sand leaves are first counted; they number from 3 to 5. The size of the sand leaves is greater than that of the top leaves.

From the fifth leaf, depending upon the age of the plant, the standard leaves are counted. These are the most valuable leaves and they vary in number. The last standard must not be less than 30 centimeters in length. So all leaves less than 30 centimeters or 11 inches are considered and counted as top leaves.

The dimension of the leaf is determined by measurements of the length and width. The length is measured from the base of the petiole to the tip, depending upon whether the petiole is winged or not. The width is measured at the broadest part of the leaf.

The best way to determine the shape of an average standard is by an accurate sketch or drawing of the leaf. If possible, it is better still to take a photograph.

To determine the texture of the leaves, press the leaf's lamina between the thumb and middle finger. Another way is to use a hand lens. The degree of gumminess is determined by the abundance of gum glands in the form of brownish knobs at the end of the hairs. The hairs occur on both surfaces of the leaves. Heavy rains, however, may reduce gumminess.

Correct sight is necessary in judging the color of the leaf in spite of the fact that it is easy to distinguish green, dark green, or light green. Color, as a rule, determines type because it varies under the same treatment and conditions.

The character of the leaf surface is easy to note. Again the hand lens is very necessary to determine the nature of pubescence, whether coarse or fine. Oily and smooth leaves go together. Some plants have their leaves dry or rough in appearance.

The position of the leaves may be shown by sketches or merely by stating whether they are erect, horizontal, or drooping, with a full understanding of the meaning of each term. The length of the internode is better determined after all the leaves are harvested. Variation in length of internode is determined by measuring the fifteenth internode.

The branching habit is determined by the tendency of certain plants to produce more suckers than others. Flower heads or clusters are judged by their size, uprightness, branching habit, and shape.

In selecting mother plants, in addition to the desirable qualities of the ideal Sumatra leaf already described, the following points should be given special consideration:

1. The leaf should be as round as possible. Round leaves give more wrappers than narrower leaves, other things being equal.

2. The position of the leaf on the stem should be as horizontal as possible. Horizontal leaves intershade better, insuring finer leaves when the plants are closely planted.

3. The shorter the internodes the greater is the number of leaves produced per unit of length. The greater the number of suckers, the less the number of leaves there will be, or the size of each leaf will be reduced. This may be due to the fact that the plant cannot feed all its parts equally so that any abnormal growth of certain parts causes the other parts to suffer. Plants with long internodes as well as plants having vigorous sucker growth, therefore, should be avoided.

4. The plants should have strong, upright, and symmetrically formed flower clusters or heads. The reasons are obvious.

5. In theory thus far light colored flowers are supposed to be correlated with light colored cured leaves.

Method of selection.—How to go about saving and caring for the seed of selected parent plants has already been explained. Because tobacco is grown in a heterogenous field, it follows that, although uniform plants may be selected for seed, the progeny from the collectively sown seed may often be quite diverse. Thre are so many characters involved, some of them invisible or latent, that in the breaking of types in subsequent generations, the extent of variation is hardly reduced. The safest and surest method, therefore, is to grow the inbred seed of each parent plant in the same plot or row. In the second generation considerable variation may still be apparent but beginning with the third generation by discarding all individuals not answering to

the ideal type and growing only the seed of those plants identical with or nearest to the ideal, one may well be assured of the uniformity of the fourth generation. Through continuous discarding of undesirable individuals and the preservation of the desirable ones by pure line cultures, the time finally comes when the highest possible degree of uniformity is manifested in a field.

Monstrosities.—Every grower is perhaps aware of so-called monstrosities or teratological occurrences in tobacco fields in the form of pitcher-like leaves, fasciated stems, etc. Various theories have been advanced to explain the causes of such occurrences as environmental, physiological, etc. But the fact that monstrosities have been definitely proven to reoccur frequently from the propagation of self-fertilized seeds of monstrous plants, indicate that such plants should be discarded absolutely. The inconveniences resulting from such occurrences are obvious.

Records.—Permanent records are essential for a better understanding of the immediate problems of the grower or breeder. Having the figures and data always on hand, one can better appreciate what is wrong with the seed or where improvement has been definitely attained. In selection as well as in hybridization, it is necessary that an accurate description of all plants in pedigree cultures be given with the most painstaking care. A good method of recording description is by following the list presented in connection with the study of variation. To this list, however, must be added the following:

Yield per acre or hectare.
Quality of cured leaf.
Quality of fermented leaf.

The opinion and the advice of cigar manufacturers or experts should be sought as a guide in determining and improving the last two properties.

Environmental considerations.—While it is an admitted fact that environment may affect the tobacco plant in growth and in composition, it cannot be a source of medium in the production of new types as claimed by certain writers. Lately sufficient evidence has been presented dispelling all possible faith in this belief. The experiments of Hasselbring and Hayes proved conclusively that crossing is the only means of producing new types. Hasselbring grew seed of tobacco from pure lines both in Cuba

and in Michigan, and found that there was no breaking up in types due to changes in environment.

Hayes noted that whatever changes take place affect all individuals of a strain in a similar manner. Hayes, after growing Cuban tobacco in pure culture, grew seed of the same in three different and distinct environments (1) in a poor gravelly loam which was manured and fertilized with chemicals, in New Haven, Connecticut; (2) in a very good and heavily fertilized inland soil at Bloomfield, Connecticut; and (3) in a seashore fertile soil at Forest Hills, Massachusetts. He found that the crops in the three places were uniform with an average mean variation of 1.8 per plant. The writers in 1916 observed that Sumatra tobacco may be grown in the Philippines without any appreciable departure from the general distinguishing characteristics of the original Sumatra type in spite of the fact that Sumatra is very near the Equator while the Philippines are much farther north.

HYBRIDIZATION

An account of the floral structure and seed development of tobacco has already been given. Strictly speaking, hybridization is the crossing of any two plants different from each other in at least one heritable character, whether they are of the same or of different variety or species. Plants are hybridized to increase their variability, thus affording more material on which to practice selection. In order to understand the rôle of hybridization in plant breeding, however, one must be acquainted with some of the underlying principles attending the problem.

In the first place, the parent plants should produce true-to-type seed after at least two to five seasons of testing, because, as will be later explained in the light of modern Mendelian studies, seed behaving with variability is actually of hybrid origin. When hybrids are crossed, matters only become worse through confusing complications.

The technique of hybridization of tobacco.—To begin with, it does not make any material difference which variety is used as the male and which as the female parent. The plant to be used as the female parent should be emasculated and prevented from setting seed fertilized by its own pollen; this should be performed before the anthers have matured. The pollen of the male plant should be applied to the stigma of the female plant when this is in a receptive condition. To prevent the intru-

sion of foreign pollen, the flowers should be bagged in the manner as for self-fertilization or inbreeding.

It appears that in tobacco, the later flowers produce larger and healthier seed than the earliest ones; this fact might well be given consideration in hybridizing. The best time for emasculation is when the flowers are apparently fully developed but the corollas still closed. In order to insure protection to the pistil, the corolla and the calyx should not be cut off as is the general practice. Artificial pollination is just as conveniently done by merely slitting the corolla at one place and piercing it at two points vertically at the middle with an ordinary pin to keep it well-open. With small scissors the anthers are easily removed. Sometimes as a means of further precaution, the stigma is washed with a dental syringe before pollinating it. The pollen should be applied with a smooth-surfaced pointed instrument like a scalpel which can be easily washed in order to be sure that only pollen of pure origin is used. Because a large number of seeds is produced in a single pod (from 3,000 to 5,000 seeds), it is not necessary to pollinate a great many flowers. All non-crossed pollinated flowers should be carefully cut out with small slender scissors.

Inheritance in plants.—It has been demonstrated by experiments in sexuality and inheritance in plants that the different plant varieties, although we designate them as such, are not wholly so homogenous and so uniform as "pure lines." When we visit a field of tobacco exhibiting variability in a greater or lesser degree, our common sense would lead us to pick the most desirable individual plants for seed. It has already been made clear, how, by insured inbreeding, we can better expect the preservation of the desirable characteristics.

Modern biologists have given the term "character" to any one of the many details of structure, form, substance, or function, which make up an individual. For example, in tobacco, we speak of the leaf size, leaf grain, branching habit, etc., as characters. The transmission of the characters of parent plants to their progeny or offspring depends on free heritable elements known as factors. In the modern science of genetics, which seeks to account for resemblances and differences exhibited among organisms related by descent, factors are expressed in ortographical symbols which are worked out mathematically in much the same manner as chemical symbols, formulae, equations,

etc. Examples of this notation will be found in the succeeding paragraphs.

This factorial systematic interpretation of inheritance is based largely upon the experiments of Gregor Mendel, discoverer of the laws of heredity. Working with garden peas, he conducted investigations on the inheritance of certain definite characters. He began his work by testing varieties of garden peas exhibiting opposite pairs of characters for two or more reasons to be sure that each variety possessed the ability of reproducing itself absolutely true from the seed. Mendel studied at least seven opposing pairs of unit characters, but for the present, by way of an illustration, only one pair will be discussed. He crossed tall and dwarf peas and found that the hybrids or the first (F^1) generation consisted only of tall plants like the tall parent. He called the tall variety the dominant type. In the second (F^2) generation by selfing the hybrids, he found that these characters split up (segregated) in a more or less uniform and definite ratio—three-fourths of the plants were tall and one-fourth was dwarf. The dwarf was then designated as recessive to the tall. In the subsequent generation (F^3), by selfing the progenies the dwarf plants produced only dwarfs, while one-third of the tall plants bred true and the other two-thirds produced both tall and dwarf plants in the same proportion as the second (F^2) generation. The numeral ratio of 1:2:1 for the F^2 generation may therefore be established.

For the sake of simplification, the factor for tallness may be repesented by "T" and the factor for the opposite character, "t". The small "t" is used for the latter because it does not find expression in the hybrid. The numerical values of the hybrids may therefore be algebraically expressed thus: TT/2Tt/tt. The resultant fusion of the gametes of both sexes is known as a "zygote".

When the fusing or uniting gametes possess the same characters, the resulting zygote is said to be a "homozygote" and its constitution, "homozygous". Pure strains of plants are, therefore, homozygous. According to these definitions, when the dwarf plants are selfed, they produce only dwarf (homozygous) progeny. On the other hand when the dwarf and tall plants are crossed the hybrids do not produce only tall plants. This is explained by the fact that the uniting gametes are unlike in constitution or character. The resulting zygote from unlike gametes is called "heterozygote" and theoretically each ovule and

pollen grain would contain both the T and t characters, combining in about equal proportions as follows:

Ovules		Pollen	
T(T)		T(T)	..... TT/2Tt/tt
t(t)	x	t(t()	

When plants having two pairs of differentiating characters were investigated by Mendel, he found that each pair of characters followed the same rule and that the inheritance of each pair was absolutely independent of the other. He crossed a tall plant bearing colored flowers with a dwarf plant bearing white flowers, the resulting F_1 hybrid (first generation) being a tall plant with colored flowers. We have a case or dominance again, that of colored over white flowers. In the F_2 generation there were plants with colored flowers and plants with white flowers in the proportion of 3:1, likewise tall plants and dwarf plants. Consequently, the chances of a tall plant having colored flowers were three times as great as its chance of having white flowers. This cross resulted, as a matter of fact, in four kinds of flowers; namely, (1) colored talls, (2) white talls, (3) colored dwarfs and (4) white dwarfs, in the ratio of 9:3:3:1, respectively. As in the case of the monohybrid, this can also be expressed as follows (T standing for tallness: t, for dwarfness; C, for colored; and c, for white flowers):

1 TTCC Tall colored
2 TtCC Tall colored
1 TTcc Tall white
2 TtCC Tall colored
4 TtCc Tall colored
2 Ttcc Tall white
1 ttCC Dwarf colored
2 ttCc Dwarf colored
1 ttcc Dwarf white

If we wish to produce a homozygous tall white, all we have to do is to select plants answering to the description of three-sixteenths of all the F_3 generation, namely, TTcc and Ttcc. From previous definition, we known that in order that a plant or strain be homozygous for tall-white it must have the formula TTcc. The only thing to do is to grow all tall-whites, preferably in head to the row cultures. The rows producing only 100 per cent tall-white plants show the pure strains resulting from the origi-

nal crossing or hybridization. The Ttcc, while all have white flowers, will split into talls and dwarfs in the ratio of 3:1, as already explained.

Mendel further pointed out that the principle may be extended indefinitely. To summarize Mendel's experiments: In crossing individuals, differing in a number of opposite characters (provided the parent plants are pure strains), the first generation of hybrids has the same appearance or form; the second generation shows a redistribution of the various characters, subject to the same rule for each character; and if the constitution of the parent is known, the number of possible forms may be calculated.

Some cases of inheritance are not based on dominance. In fact, various logical explanations have been advanced for all kinds of resulting ratios other than 3:1. We shall, however, refer specifically to that type of inheritance in which the characters "blend," that is, the offspring (F_1 hybrid) possesses a character more or less intermediate to those of the parents. This is especially true in the case of size characters. The F_2 generation however, exhibit so much variability that size inheritance is also expressable by Mendelian notation.

In presenting the foregoing account, the writers merely desire to give to the average tobacco grower the underlying facts about hybridization which are now generally accepted and at the same time honor the memory of the discoverer of the laws of heredity. Indeed, detailed knowledge of heredity in tobacco and, in fact, in all living forms in general, involves vast and complex problems for which even over a long period of time, it would be impossible to reach conclusive explanations or solutions. At any rate, the grower's as well as the manufacturer's concern is merely the ultimate product and not the complicated extensive technical and mathematical studies involved.

When hybridization is practiced, the work is started with a definite ideal in mind so that the parent plants selected may possess as many as possible of the qualities sought in the new form. An illustration of this is the attempt of the Connecticut Agricultural Experiment Station to combine the well-shaped (rounded) leaves of the Sumatra variety with the large size and excellent qualities of the Havana. After ten years of constant selection, the efforts of the station were finally crowned with the successful production of the now known Connecticut round tip variety. We say "variety" because it differs from any other known standard variety and it breeds true just as the Sumatra or the

Havana types. This point should indeed be noted carefully. A new plant or strain may be produced by hybridization, but it continues to be called a hybrid only so long as it exhibits great variability. As soon as it breeds true, it is no longer known as a hybrid but as a variety. As it may be recalled, this resulting combination of the round tip of the Sumatra and the large size of the Havana has been brought about in much the same way as the tall-white flowered peas resulted from a cross between tall-colored and dwarf-white parents.

In practice, a sufficiently large number of the third (F_3) generation is propagated in "pure line" cultures (head-to-the-row) in order to test the possibility of obtaining the desired combinations of characters. While mathematically and by expert work, definite results may be obtainable in the fourth or fifth generations, the vast operations involved sometimes delay results for ten years or more. Ordinary selection methods conducted in limited cultures are therefore resorted to instead.

Utilization of first filial generation hybrids in crop improvement with special reference to tobacco.—Hybrid vigor in plants was first observed about two centuries ago by Kolreuter, but it was only in 1917 that the phenomenon was satisfactorily accounted for as being due to the complementary action of dominant factors and termed "heterosis" by Jones of the Connecticut Agricultural Experiment Station, U. S. A.

In the United States and in Europe, especially among seed and plant dealers, hybrid vigor has long been utilized but apparently, up to the present time, it is being neglected in the Philippines. The only instance of its application locally is the Alunan (Badila x P. O. J. 24) and P. S. A. 14 sugar cane. Of course, it is also manifested in some native fruits, but this is not realized.

The utilization of hybrid vigor or heterosis is based chiefly on the established law of heredity to the effect the "when pure races or strains are crossed, the population composing the first filial generations is similar to the parents in uniformity." This is mathematically expressed from the observation that if any particular factors XX and xx are pure or homozygous in the parents, only Xx individuals can be formed in the F_1 generation. This law of heredity therefore satisfies a primary essential in crop production—uniformity.

Because of heterosis the second primary essential in crop production—higher yield—is also obtained. Incidentally other desirable qualities are at least retained if not enhanced.

The utilization of hybrids is generally practicable in the case of plants that are reproduced asexually. Otherwise, it is subject to limitations which are primarily and obviously governed by the facility of making the crossing and the profitableness of the resultant yields of the crosses.

As regards crops, especially annual ones reproduced or propagated only by seeds, the limitations are greater. Aside from those already given, the fact that the operation of crossing must be performed yearly in order to insure the supply of fresh seeds limits the production of F_1 hybrid seeds to a few crops.

In the case of tobacco, a plant ordinarily produces 42 pods with a total of about 90,000 seeds. Since it takes only $\frac{1}{2}$ minute to cross a flower, in about half an hour, therefore, the flowers of a plant can be crossed. And assuming only 75 per cent viability of the 90,000 seeds, one can grow about 3 hectares of tobacco from the seeds of one plant alone. Leaves produced from F_1 wrapper tobacco hybrids have actually been sold for ₱8 per kilo.

The advantages of F_1 hybrids are (1) immediate results, (2) increased yield, (3) improved quality, (4) maximum uniformity, (5) higher seed viability, and (6) rapid growth.

Through hybridization followed by selection, it takes from 4 to 20 years to obtain uniformity, and once this is attained, the question of yield cannot be guaranteed to equal even that of the higher yielding parent since homozygosity is synonymous with the absence of heterosis.

It is obvious that the best descendant of a cross cannot exhibit any superior trait to any identical trait of either of its parents.

The real reason why seeds of most annuals purchased from American and European seed dealers produce uniform and vigorous plants the first year and fail to repeat the performance the following year, is that they are really F_1 hybrids. Seed dealers in these continents thrive well because they possess the secret and the original races of the parents of the desirable F_1 hybrids. The original races are continually inbred and at the same time fresh F_1 hybrids are produced yearly.

ACCLIMATIZATION

It is a well-established fact that some plants are grown to better advantage in some localities than in others. When an effort is made to introduce a foreign valuable plant into a new

locality, it does not usually follow that the plant retains the same characteristic in the same degree as it did in its former environment. Differences of soil and climate conditions may be the factors directly responsible for contrary behavior. There are cases, however, where in the course of two to five years of continuous testing, the plant will finally thrive normally in its new home. The testing of the plant in a new locality, therefore, for the purpose of introducing it to this locality, is called acclimatization, and the result of the tests may either be negatively or positively economical.

FIG. 7. Bags of tobacco seeds thoroughly cleaned ready for distribution.

There is no better example of this method of improving wrapper tobacco than the attempt to introduce Cuban and Sumatra varieties into the Connecticut Valley. In spite of all kinds of cultural as well as selection efforts to produce a desirable wrapper strain from introduced seed of the famous Sumatra variety, and while the plants to all appearances resembled the genuine or original strain, the quality of the product was always decidedly inferior; finally all attempts to acclimatize it were abandoned. On the other hand, seed of the Cuban variety with the aid of selection, not only thrives favorably in Connecticut but its size, quality, and flavor are even superior. It is now used for growing under artificial shade to the complete exclusion of Sumatra.

MUTATION IN TOBACCO

When a different plant is derived from a parent plant by means of a sudden leap, a result of its seed being grown in separate cultures, and when it breeds true, just as the rest of the seed of the parent plant, to the characters which have distinguished it constantly from generation to generation, it is claimed that the

new plant is either a new variety or a new species, and it is called a mutant or sport—that is, it is produced by mutation. Because of this assertion, the well-known Stewart Cuban tobacco, which originated from a field of a supposedly pure strain of Cuban tobacco, is called a mutant. The Stewart Cuban produces 72 leaves, acquire considerable height, and flowers late as compared with the normal original Cuban which has a mean of 19.9 leaves only.

While mutants are decidedly dependent upon chance, it is well that the grower or the breeder be always on the lookout for them.

SEED SEPARATION

It has been proven that a plant, however healthy or vigorous it may be, produces a considerable quantity of light seeds, and that these seeds do not produce such healthy plants as the heavy one. These facts render the production of uniform crop very uncertain. The case is similar to that of a sickly child born of healthy parents whose other children are all robust and sturdy.

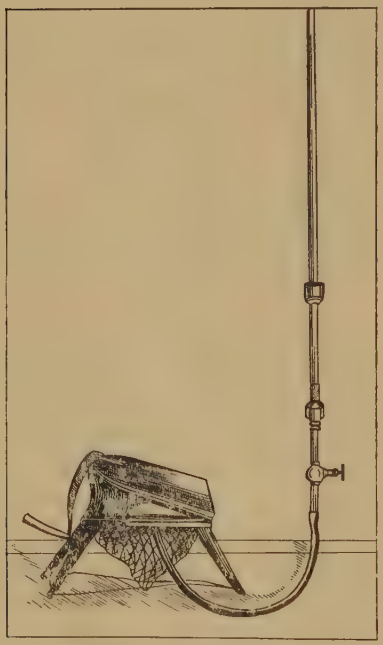

FIG. 8. Apparatus for cleaning tobacco seed.

While various ways may be used to bring about the separation of heavy from light seeds, among which is winnowing, a very convenient apparatus called the tobacco seed separator has been successfully devised by Shamel and Cobey of the U. S. Department of Agriculture. By the improved apparatus a current of air is generated by stepping on the foot bellows. The air passes through the rubber tube and then through the glove valve which regulates the passage of the desired amount of air to accomplish the best separation. The air proceeds through a half inch wide iron tube and then goes out of the top of a larger glass tube, carrying with it the undesirable light seeds. A metallic joint covered with fine wire gauze to prevent the seed from falling into the bellows, is located at the base of the one-

inch glass tube which is 5 to 6 feet long. By using about an ounce of seed at each operation, a pound of seed may be separated in less than half an hour.

The apparatus is cheap and can be prepared at home with the help of a mechanic. It is now purchaseable from hardware or chemical supply houses. Being of common use, it is advisable that a group of growers coöperatively own one well-made apparatus. In the Philippines at one time every municipal government in the tobacco districts owned one tobacco seed separator for the general use of its citizens. Growers took their seed to the town hall where the apparatus was always available.

Appendix A

CLASSIFICATION AND BAILING OF SUMATRA WRAPPERS

Sumatra wrappers are first classified according to color and soundness as follows:

Dutch abbreviations or markings	*English descriptions*
L	Very light brown
LB	Light brown
LL	Light brown, slightly speckled
BBL	Light brown, speckled
V	Fallow (mousy brown)
LV	Light fallow—the most prized color
VV	Dark fallow
SV	Fallow, slightly speckled
B	Brown
SB	Brown, partly speckled
BB	Brown, speckled
D	Dark Brown
SD	Dark brown, slightly speckled and broken
BD	Dark brown, speckled
K	Assorted, clean but lifeless
SK	Assorted, dirty and lifeless
KL	Light but lifeless
X	Broken or worm-eaten
XX	Badly broken
O	Discarded, thrash and refuse

After the color classification, the leaves are sorted according to four sizes only. There are no standard lengths but the crop of each year is sorted into four sizes for convenience. Consequently, when the year is favorable, the first size-class may be much longer than the same class of an unfavorable year. As a rule however, the leaves may fall within 15–, 25–, 30–, 38–, and 46–centimeter lengths.

After sorting, the leaves are rebundled into 35 or 40 in each bundle, after which, they are ready to be pressed and baled.

The baling apparatus used in Sumatra is the same as that used in the Philippine, but the methods of arranging the leaves in the bales as well as the general handling of the apparatus are markedly different. Without counting the number of the bundles, a lot weighing 80 kilograms is placed in a collapsible wooden receptacle 30 inches square and over 2 feet high and this slides under the press on rollers. Pieces of tightly woven pandan mattings are placed above then below the receptacle after the bundles have been put in, with the petioles pointing outward. The receptacle is then placed exactly under the press, the iron cover is lowered, the sides are removed, and pressing is continued until the bale has been squeezed to about a foot in height only. Bales of Sumatra tobacco are of uniform size, that is, 30 by 30 inches by 9 to 12 inches in height depending on the size of the leaves to be baled. The bigger the size the higher the bale.

When the desired height of the bale has been reached, the matting at the top and bottom are pulled together and sewed up. The bale is removed, marked with the grade and other identification marks and is ready for shipping. The method of regulating the pressure exerted in the baling of tobacco as observed in Sumatra and in Cuba undoubtedly is a very sound practice. The leaves are not deprived entirely of the necessary moisture for maintaining the so-called 'life" of sound cigar tobacco in general and of wrapper tobacco in particular.

The bales of Sumatra tobacco are usually marked thus—

BK/1917/XLV/3

BK stands for the sign or mark of the estate in which the crop was raised.

1917 stands for the year of the crop.

4 stands for the shipment series (that is, the 4th shipment).

XLV stands for broken leaves of light fallow color.

3. means that the size of the leaves is that of the 3rd group.

Appendix B

CLASSIFICATION AND BALING OF SHADE-GROWN TOBACCO IN CUBA

Classification.—The sound leaves par excellence are sorted out according to size into three main groups which in turn are subdivided into three main kinds of fineness.

A. First—1a/10a, S(Dry), 1a/10a, F(fine), and 1a/10a, Mt. (Medium).
Second—11a/12a, S(Dry), 11a/12a, F(fine), and 11a/10a, Mt. (Medium).
Third—13a, S(Dry), 13a/ F(fine), and 13a/ Mt. (Medium).

There is no exact standard for size because the size of any one leaf depends on the season. Suffice it to say that the first group represents the largest, which are about 50 cm. in length, and the last represent the smallest of the most perfect and sound wrappers (from 1a/ to 15a/). "S" is the abbreviation for *Seco* or *Ligero*, "F" for *Fina* and "Mt" for *Medio Tiempo*.

B. Leaves of the same sizes as above but which, due to some flaw or other cannot be included in any of the A sets. They are designated as *rezagos*.

1st-1a/3a. Rgo. 1a/ S. Rgo. 1a/F. Rgo. 1a/MT.
2nd-4a/ Rgo. 2a/ S. Rgo. 2a/F. Rgo. 2a/Mt.
3rd-5a/ Rgo. 3a/ S. Rgo. 3a/F. Rgo. 3a/MT.

C. Besides these, there are two other *Rezago* classes designated as Rgo. 6a/7a, that include the leaves not up to the 1a/5a class.

D. Still further extra grade, which is suitable as binder either, as 14a/ F. and 14a/ S. or 16a/ Rgo.

E. Likewise a clean grade of filler known as (15a/ or 16a/)

F. A type of filler known as *dispalillable* is also separated and is designated 16a/–17a/.

G. Two grades known as *Volados* are obtained:

Volado No. 1 includes all large leaves which are chaffy greenish (*volado, verdosa, sin vida y vaciada*). These can be fixed up so that they can be used for filler. A leaf may supply enough tobacco for a cigar.

Volado No. 2 Includes similar but decidedly small leaves.

Volado No. 1 are usually discarded from the larger classes and should be inferior to Rgo. 1a/Volado No. 2 are discarded from the filler grade 17a/.

H. A filler grade of coarser texture is separated from the ordinary filler grades, 15a/16a and is called 15a/*de Calidad.*

I. Two grades known as *Quebrados:*

Quebrado No. 1 consists of heavier or rougher leaves Rgo. 4a/5a.

Quebrado No. 2 consists of leaves under the same conditions but derived from other than the preceding. It is distinguished from the *Volados* in that the latter are of lighter texture.

J. Two grades known as *Sentidos:*
Sentido No. 1. Large partly decayed leaves.
Sentido No. 2. Small partly decayed leaves.
K. Two grades of clear cut yellow or very pale leaves:
Amarillo No. 1 (large) and *Amarillo No. 2* (small).
L. *Bote* includes all that cannot be classified with any of the above.

TABLE I.—*Number of leaves in each hand*

Representative grades	*No. of leaves*
1a/10a—*Rgo. 1a*	35
11a/12a—*Rgo. 2a*	40
13a/*Rgo. 3a*	45
14a/*Rgo.*	60
Rgo. 4a	50
Rgo. 5a	55
Qdo. 1a	50
Qdo. 2a	55
Volado 1a	40
Volado 2a	In *gavillas* (1/4) of a hand *bultos*
15/16a	8 ounces *gavilla*
1a	are baled in *gavillas* without being bundled into *manojos.*

TABLE II.—*Classification terms and equivalents*

1 *Tercio* = 50 *cujes* (poles) in *mancuernas* (pair of grown leaves harvested with stalk).
1 *Tercio* = 110 *cujes* of primed leaves.
1 *Tercio* = 550 cujitos (short poles) of primed leaves.
1 *Tercio* = 80 *manojos* (hand).
1 *Manojo* = 4 *gavillas.*
1 *Gavilla* = 33 to 60 leaves of wrapper or binders.
1 *Gavilla* = 6 oz. leaves of fillers.

Baling.—After the leaves have been classified, they are rebundled or retied into hands according to Table I. A hand is tied with raffia fiber which is wound around it spirally so that it becomes fusiform in shape. The hand at the base of the leaves is tied with one of the leaves constituting the hand itself. The hands are then ready to be baled right away. As a rule when the weather permits, the classified leaves are baled the same day.

The baling apparatus is a simple thing. It consists of flat, rather heavy boards 2.5 meters long supported at the middle of its sides by heavier narrow boards 1.5 meters long. These are connected below the base board by two flat, thinner boards which pass through one side of the apparatus according to the size of the bale to be made. At one end of the connecting boards are set alternately half a dozen holes for the purpose. The connecting boards are 1.2 meters long. On the top of the side boards are 4 slightly tapering small supports which are 15 centimeters apart. Between these supports are a pair of sticks to hold the string for tying the bundle. These supports are 60 centimeters high and 4.5 centimeters square at the top. The two centers have removable sticks with which to hold firmly a broad petiole of the royal palm (*Roystonia regia* Cook) which is the material used exclusively in the baling of tobacco leaves in Cuba. The rope used to tie the bales is derived from the fibrous cortex of a malvaceous plant commonly known as *majaguar* (*Hibiscus tiliaceous.* Lin.).

Four pieces of royal palm petioles are required ordinarily for packing a bale of Cuban tobacco. A piece of these petioles is usually 1 meter by 1.5 meters. As these materials are very strong and very compact, they are ideal for the purpose, besides being cheap and abundant.

A bale always contains only 80 hands irrespective of its grade. The hands are arranged in two layers with the butts of the leaves pointing towards the ends of the bales. The upper and lower layers contain 13 hands each and the central layers 14 hands.

The main feature of this process in that the leaves are not actually pressed by machinery. Only hand pressure is employed. This method is very sensible inasmuch as the moisture which is vital in the conservation of the so-called "life" of the leaf tobacco is not squeezed out. It is possible that the pressing of Philippine tobacco to the limit, it is ventured to say, by the use of powerful mechanical apparatus, is responsible for the deficiency of aroma and flavor so justly complained about by American jobbers, and smokers. Indeed, practically all Philippine leaf tobacco examined by the senior writer while in New York City is wanting in the elastic or pliable property which is an obvious indication that a leaf is not "dead" but "alive."

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APPENDIX C

STANDARD GRADES OF THE CONNECTICUT HAVANA SEEDLEAF AND BROADLEAF

(Prepared by the Tobacco Standardization Section, United States Department of Agriculture)

I. STANDARD GRADES FOR CONNECTICUT HAVANA SEED—TYPE 51

Key to Grade Marks

Groups	*Qualities*	*Colors*	*Lengths 75 per cent Size Between*
A—Wrappers	1—1st quality	L—Light	15–14″ to 16″
B—Second or binders	2—2nd quality	C—Chestnut	17–16″ to 18″
C—Tops and fillers	3—3rd quality	or medium	19–18″ to 20″
X—Brokes and nondescript	4—4th quality	D—Dark	21–20″ to 22″
Y—Stemmers	9—Wet tobacco	M—mixed colors	23–22″ to 24″
			25–24″ to 26″
			27–26″ to 28″

Damaged Tobacco

All damaged tobacco to be marked to show the kind and the percentage (or amount) of damage, after the grade designation. For example A2L25 Black rot 6 layers.

First Factor Group	*Second Factor Qualities*	*Third Factor Colors*	*Fourth Factor Lengths or Sizes*
A	1, 2, and 3	L, C, and D	27, 25, 23, 21, 19, 17
B	1, 2, 3, and 9	L and D	27, 25, 23, 21, 19, 17, 15
C	1, 2, and 9	No color Mark	No length Designated
X	1, 2, 3 and 9	No color Mark	No length Designated

LIST OF CONNECTICUT HAVANA SEED GRADES

Light Wrappers (A Group)

Standard Grade	*Description of Grades*	*Old Grade Mark*
A 1 L 27	Choice quality—26″ to 28″	Light wrapper 28″ Pool 1
A 1 L 25	Choice quality—24″ to 26″	Light wrapper 26″ Pool 1
A 1 L 23	Choice quality—22″ to 24″	Light wrapper 24″ Pool 1
A 1 L 21	Choice quality—20″ to 22″	Light wrapper 22″ Pool 1
A 1 L 19	Choice quality—18″ to 20″	Light wrapper 20″ Pool 1
A 1 L 17	Choice quality—16″ to 18″	Light wrapper 18″ Pool 1
A 2 L 27	Good quality—26″ to 28″	Light wrapper 28″ Pool 2
A 2 L 25	Good quality—24″ to 26″	Light wrapper 26″ Pool 2
A 2 L 23	Good quality—22″ to 24″	Light wrapper 24″ Pool 2
A 2 L 21	Good quality—20″ to 22″	Light wrapper 22″ Pool 2
A 2 L 19	Good quality—18″ to 20″	Light wrapper 20″ Pool 2
A 3 L 27	Fair quality—26″ to 28″	Light wrapper 28″ Pool 3
A 4 L 25	Fair quality—24″ to 26″	Light wrapper 26″ Pool 3
A 3 L 23	Fair quality—22″ to 24″	Light wrapper 24″ Pool 3
A 3 L 21	Fair quality—20″ to 22″	Light wrapper 22″ Pool 3
A 3 L 19	Fair quality—18″ to 20″	Light wrapper 20″ Pool 3

Medium Wrappers (A Group)

Standard Grade	*Description of Grades*	*Old Grade Mark*
A 1 C 27	Choice quality—26″ to 28″	Med. wrapper 28″ Pool 1
A 1 C 25	Choice quality—24″ to 26″	Med. wrapper 26″ Pool 1
A 1 C 23	Choice quality—22″ to 24″	Med. wrapper 24″ Pool 1
A 1 C 21	Choice quality—20″ to 22″	Med. wrapper 22″ Pool 1
A 2 C 27	Good quality—26″ to 28″	Med. wrapper 28″ Pool 2
A 2 C 25	Good quality—24″ to 26″	Med. wrapper 26″ Pool 2
A 2 C 23	Good quality—22″ to 24″	Med. wrapper 24″ Pool 2
A 2 C 21	Good quality—20″ to 22″	Med. wrapper 22″ Pool 2
A 3 C 27	Fair quality—26″ to 28″	Med. wrapper 28″ Pool 3
A 3 C 25	Fair quality—24″ to 26″	Med. wrapper 26″ Pool 3
A 3 C 23	Fair quality—22″ to 24″	Med. wrapper 24″ Pool 3
A 3 C 21	Fair quality—20″ to 22″	Med. wrapper 22″ Pool 3

Dark Wrappers (A Group)

Standard Grade	*Description of Grades*	*Old Grade Mark*
A 1 D 27	Good quality—26″ to 28″	Dark wrapper 28″ Pool 1
A 1 D 25	Good quality—24″ to 26″	Dark wrapper 26″ Pool 1
A 1 D 23	Good quality—22″ to 24″	Dark wrapper 24″ Pool 1
A 1 D 21	Good qualtiy—20″ to 22″	Dark wrapper 22″ Pool 1
A 2 D 27	Fair quality—26″ to 28″	Dark wrapper 28″ Pool 2
A 2 D 25	Fair quality—24″ to 26″	Dark wrapper 26″ Pool 2
A 2 D 23	Fair quality—22″ to 24″	Dark wrapper 24″ Pool 2
A 2 D 21	Fair quality—20″ to 22″	Dark wrapper 22″ Pool 2

Seconds or Binders (B Group)

B 1 L 27	Choice quality light—26″ to 28″	Seconds 28″ Pool 1
B 1 L 25	Choice quality light—24″ to 26″	Seconds 26″ Pool 1
B 1 L 23	Choice quality light—22″ to 24″	Seconds 24″ Pool 1
B 1 L 21	Choice quality light—20″ to 22″	Seconds 22″ Pool 1
B 1 L 19	Choice quality light—18″ to 20″	Seconds 20″ Pool 1
B 1 L 17	Choice quality light—16″ to 18″	Seconds 18″ Pool 1
B 1 L 15	Choice quality light—14″ to 16″	Seconds 16″ Pool 1
B 2 L 27	Good quality light—26″ to 28″	Seconds 28″ Pool 2
B 2 L 25	Good quality light—24″ to 26″	Seconds 26″ Pool 2
B 2 L 23	Good quality light—22′ to 24′	Seconds 24″ Pool 2
B 2 L 21	Good quality light—20″ to 22″	Seconds 22″ Pool 2
B 2 L 19	Good quality light—18″ to 20″	Seconds 20″ Pool 2
B 2 L 17	Good quality light—16″ to 18″	Seconds 18″ Pool 2
B 2 L 15	Good quality light—14″ to 16″	Seconds 16″ Pool 2
B 2 L 27	Fair quality light—26″ to 28″	Seconds 28″ Pool 3
B 2 L 25	Fair quality light—24″ to 26″	Seconds 26″ Pool 3
B 2 L 23	Fair quality light—22″ to 24″	Seconds 24″ Pool 3
B 2 L 21	Fair quality light—20″ to 22″	Seconds 22″ Pool 3
B 2 L 19	Fair quality light—18″ to 20″	Seconds 20″ Pool 3
B 2 L 17	Fair quality light—16″ to 18″	Seconds 18″ Pool 3
B 2 L 15	Fair quality light—14″ to 16″	Seconds 16″ Pool 3

Dark Binders (B Group)

B 1 D 19	Good quality dark binder—18″ to 20″	Dark wrapper 20″ Pool 1

Fillers and Tops (C Group)

Standard Grade	*Description of Grade*	*Old Grade Mark*
C 1 D 21	Good quality dark—20" to 22"	Dark wrapper 22" Pool 3
C 1 D 19	Good quality dark—18' to 20'	Dark wrapper 20" Pool 2
C 1 D 17	Good quality dark—16" to 18"	Dark wrapper 18" Pool 1
C 1 D 15	Good quality dark—14" to 16"	Dark wrapper 16" Pool 1
C 2 D 17	Fair quality dark—16" to 18"	Dark wrapper 18" Pool 2
C 2 D 15	Fair quality dark—14" to 16"	Dark wrapper 16" Pool 2

Brokes or Nondescript (X Group)

X 1	Good Quality Clean Brokes
X 2	Fair Quality Clain Brokes
X 3	Common Quality Clean Brokes

Stemmers (Y Group)

Y 1	Good Clean Ground Leaves	Fillers
Y 2	Fairly Clean Ground Leaves	Fillers
Y 3	Common and Dirty Ground Leaves	Fillers

Wet tobacco (Mixed Groups)

B 9	Wet-Pick for Binders (Best Wet)	Wet
C 9	Wet-Pick for Fillers (Medium Quality Wet)	Wet
X 9	Wet-Low Grade or Stemming and Nondescript (Common)	Wet

SUMMARY OF CONNECTICUT HAVANA SEED GRADES—TYPE 51

Wrappers (A Group)

A 1 L	27 25 23 21 19 17	Choice Quality Light Wrapper
A 2 L	27 25 23 21 19	Good Quality Light Wrapper
A 3 L	27 25 23 21 19	Fair Quality Light Wrapper
A 1 C	27 25 23 21	Choice Quality Medium Wrapper
A 2 C	27 25 23 21	Good Quality Medium Wrapper
A 3 C	27 25 23 21	Fair Quality Medium Wrapper
A 1 D	27 25 23 21	Good Quality Dark Wrapper
A 2 D	27 25 23 21	Fair Quality Dark Wrapper

Fillers and Tops (C Group)

C 1 D	21 19 17 15	Good quality dark fillers
C 2 D	17 15	Fair quality dark fillers

Brokes or Nondescript (X Group)

X 1	Good quality clean brokes
X 2	Fair quality clean brokes
X 3	Common quality clean brokes

Stemmers (Y Group)

Y 1	Good quality clean stemmers
Y 2	Fairly clean stemmers
Y 3	Common and dirty stemmers

Wet Tobacco (Mixed Groups)

B 9	Wet—Pick for binders (Best Wet)
C 9	Wet—Pick for Fillers (Medium Quality Wet)
X 9	Wet—Low Grade or Stemming and Nondescript (Common)

These grades were prepared by the Tobacco Standardization Section of the U. S. Department of Agriculture on August 28, 1923.

II. STANDARD GRADES FOR CONNECTICUT BROADLEAF–TYPE 52

Strain 521—John Williams
Strain 522—Bantle
Strain 523—Hockman
Strain 524—Barber

Key to Grade Marks

Groups	*Qualities*	*Colors*
A—Wrappers	1—1st Quality	L—Light
B—Seconds or Binders	2—2nd Quality	C—Chestnut or Medium
C—Tops or Fillers	3—3rd Quality	D—Dark
X—Brokes and Nondescript	4—4th Quality	M—Mixed Colors
Y—Stemmers	9—Wet tobacco	

Lengths

	Leaves Averaging in Length	
	Size	*Between*
Lengths not considered except in Short	43	12″ to 16″
Seconds which are indicated by numbers	44	16″ to 20″
	45	20″ to 24″

Damaged Tobacco

All damaged tobacco to be marked to show the kind and the percentage (or amount) or damage, after the grade designation. For example, A2L Black-rot, 6 layers.

Qualities, Colors, and Lengths in Each Group

First Factor Group	*Second Factor Qualities*	*Third Factor Colors*	*Fourth Factor Lengths or sizes*
A	1, 2, 3 and 4	L, C, and D	No lengths designated
B	1, 2, 3, and 9	L and D	44 and 43
C	1, 2, 3, and 9	D	No length designated
X	1, 2, 3, and 9	No color Mark	No length designated
Y	1, 2 and 3	No color Mark	No length designated

LIST OF CONNECTICUT BROADLEAF GRADES

Light Wrappers (A Group)

Standard Grade	*Description of Grade*	*Old Grade Mark*
A 1 L	Choice quality	Light wrapper Pool 1
A 2 L	Good quality	Light wrapper Pool 2
A 3 L	Fair quality	Light wrapper Pool 3
A 4 L	Common quality	Light wrapper Pool 4

Medium Wrappers (A Group)

Standard Grade	*Description of Grade*	*Old Grade Mark*
A 1 C	Choice quality	Medium wrapper Pool 1
A 2 C	Good quality	Medium wrapper Pool 2
A 3 C	Fair quality	Medium wrapper Pool 3
A 4 C	Common quality	Medium wrapper Pool 4

Dark Wrappers (A Group)

A 1 D	Choice quality	Dark wrapper Pool 1
A 2 D	Good quality	Dark wrapper Pool 2
A 3 D	Fair quality	Dark wrapper Pool 3
A 4 D	Common quality	Dark wrapper Pool 4

Long Seconds (B Group)

B 1 L	Good quality light colored	Long sections Pool 1
B 2 L	Fair quality light colored	Long sections Pool 2
B 3 L	Common quality light colored	Long sections Pool 3

Short Seconds (B Group)

Standard Grade	*Description of Grade*		*Old Grade Mark*	
B 1 L 44	Good quality light colored	—16" to 20"	Short sections	Pool 1
B 2 L 44	Fair quality light colored	—16" to 20"	Short sections	Pool 2
B 3 L 44	Common quality light colored	—16" to 20"	Short sections	Pool 3

Short Seconds (B Group)

B 1 L 43	Good quality light colored binder	—12" to 16"	Short sections	Pool 1
B 2 L 43	Fair quality light colored binder	—12" to 16"	Short sections	Pool 2
B 3 L 43	Common quality light colored binder	—12" to 16"	Short seconds	Pool 3

No. 2 Seconds (B Group)

B 1 M	Good quality off colored binder	No. 2 sections	Pool 1
B 2 M	Fair quality off colored binder	No. 2 sections	Pool 2
B 3 M	Common quality off colored binder	No. 3 sections	Pool 3

No. 2 Dark Wrappers (B Group)

Standard Grade	*Description of Grade*	*Old Grade Mark*	
B 1 D	Good quality	No. 2 Dark wrapper	Pool 1
B 2 D	Fair quality	No. 2 Dark wrapper	Pool 2
B 3 D	Common quality	No. 2 Dark wrapper	Pool 3

Fillers or Tops (C Group)

C 1 D	Good quality fillers	Tops	Pool 1
C 2 D	Fair quality fillers	Tops	Pool 2
C 3 D	Common quality fillers	Tops	Pool 3

Brokes and Nondescript (X Group)

X 1	Good quality clean	Brokes	Pool 1
X 2	Fair quality clean	Brokes	Pool 2
X 3	Common quality clean	Brokes	Pool 3

Stemmers (Y Group)

Standard Grade	*Description of Grade*	*Old Grade Mark*	
Y 1	Good clean ground leaves	Fillers	Pool 1
Y 2	Fairly clean ground leaves	Fillers	Pool 2
Y 3	Common, dirty ground leaves	Fillers	Pool 3

Wet Tobacco (Mixed Groups)

B 9	Wet—Pick for Binders (Best wet)	Wet
C 9	Wet—Pick for Fillers (Medium quality wet)	Wet
X 9	Wet—Low Grade or Stemming and Nondescript (Common)	Wet

REMARKS

Tobacco is graded under the standard system according to quality, color and length. The quality factor is divided into groups of similar quality in order to simplify the grading. Assorting (sometimes called grading) is the act separating tobacco into lots of like quality, color and length. Grading is the act of examining a lot of tobacco (after it has been assorted) and determining into what grade it belongs.

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ILLUSTRATIONS

PLATE 1

Bales of filler tobacco in a warehouse of one of the leading cigar factories in Manila, Philippine Islands.

PLATE 2

FIG. 1. Assorting filler tobacco for cigar manufacture.
2. Stemming cigar filler tobacco for cigar manufacture.

PLATE 3

Different brands, shapes and sizes of cigars.

PLATE 4

FIG. 1. A typical plant of the variety "Simmaba" ("Marogui"), Los Baños Economic Garden, Los Baños, Laguna, Philippine Islands.
2. A typical plant of the variety "Ilagan Sumatra," Los Baños Economic Garden, Los Baños, Laguna. This variety is a strain of the genuine Sumatra developed by the Ilagan Tobacco Experiment Station, Ilagan, Isabela, Philippine Islands, by continuous selection.
3. A typical plant of the variety "Viscaya," Los Baños Economic Garden, Los Baños, Laguna, Philippine Islands.

PLATE 5

1. Seedlings forty-five days old ready for transplanting.
2. Tobacco seedlings dusted with calcium arsenate and sterilized dust mixture to control the ravages of worms.

PLATE 6

1. The cultivation of wrapper tobacco by ridging.
2. The cultivation of wrapper tobacco by banking or the so-called, "Sumatra method."

PLATE 7

1. Dusting open-grown wrapper tobacco with calcium arsenate mixtures by the use of a hand dusting machine.
2. Dusting open-grown wrapper tobacco with calcium arsenate mixture by the use of a cheese cloth bag.

PLATE 8

1. Topping and removing suckers of shade-grown wrapper tobacco in Cuba.
2. Gathering wrapper tobacco, Cuba.

PLATE 9

FIG. 1. Growing wrapper tobacco in Cuba under shade of royal palm (*Roystonea regia*) leaves.
2. Wrapper tobacco grown under abacá cloth in Los Baños Economic Garden, Los Baños, Laguna, P. Islands. The sand, lower and middle standard leaves were already harvested.

PLATE 10

1. Wrapper tobacco grown under shade of talahib grass (*Saccharum spontaneum* in Rosales, Pangasinan, Philippine Islands.
2. Wrapper tobacco grown under shade of talahib grass (*Saccharum spontaneum*) in Naguilian, Isabela, Philippine Islands.

PLATE 11

Stringing wrapper tobacco in the Philippines.

PLATE 12

1. Fresh leaves newly strung and hung on the racks to cure.
2. Cured wrapper tobacco ready to be put down and bundled for fermentation.

PLATE 13

1. A typical fermenting house in Sumatra.
2. Classifying and grading wrapper tobacco in Sumatra. Note the adequate ventilation of the building to properly accomplish the grading and classification work.

PLATE 14

A typical cigar factory in the Philippine Islands.

PLATE 15

1. Stemming tobacco in Cuba.
2. Drying stemmed tobacco in Cuba.

PLATE 16

1. Classifying cigars according to color.
2. Sterilizing cigars in a gas heated room before packing.

PLATE 17

1. Cigars in boxes ready to be sealed after the last touch.
2. Banding cigars with beautifully lithographed rings preparatory to sealing the boxes.

PLATE 18

Branding cigar boxes.

PLATE 19

Principal shapes of cigars.

PLATE 20

FIG. 1. The true bud worm (*Heliothis virescons* Fab.): *a*, adult moth; *b*, full-grown larva from side; *c* same from above; *d*, seed pod bored into by larva; *e*, pupa ½ natural size. (After Howard.)

2. The tobacco split worm (*Gelechia operculella* Zell). Adult moth above; pupa below at left with side view of enlarged anal segment; larva below at right-all enlarged. (After Howard.)

3. A tobacco cut worm (*Peridromia saucia*): *a*, moth; *b*, normal form of larva, side view; *c*, same in curved position; *d*, dark form of larva from above; *e*, egg, from side *f*, egg mass on twig. All ½ natural size except *e*, which is enlarged. (After Howard.)

4. *Agrotis Ypsilon*, one of the tobacco cut worms: *a*, larva; *b*, head of same; *c*, adult ½ natural size. (After Howard.)

PLATE 21

1. The mosaic disease of tobacco.
2. Tobacco plants severely damaged by tobacco worms.

PLATE 22

1. The suck fly (*Dicyphus minimus*): *a*, newly hatched; *b*, second stage; *c*, nymph; *d*, adult, *e*, head and beak from side—enlarged. (After Howard.)
2. Northern tobacco worm, or "horn worm" (*Phlegethontius quinquemaculata*) *a*, adult moth; *b*, full-grown larva; *c*, pupa ⅔ natural size. (After Howard.)

PLATE 23

1. The tobacco (*Lasioderma serricorne*, Fabr.): *a*, larva; *b*, pupa; *c*, adult; *d*, leaf tobacco severely damaged by beetle *a*, *b*, and *c*. (After Chittenden).
2. Cigars damaged by the tobacco beetle.

PLATE 24

1. A tobacco plant attacked by the fussarium wilt disease.
2. Tobaco plants showing sign of bacterial wilt infection.

PLATE 25

1. Root-knot disease (*Heterodera radicola*). The knots on the roots are typical symptoms of the disease.
2. Sclorotium blight. The constrictions of the attacked parts of the stalks and presence of white fungus micelia are very typical.

PLATE 26

1. Selected plants in a Sumatra variety plot newly bagged to insure self-fertilization. Ilagan Tobacco Experiment Station, Ilagan, Isabela, Philippine Islands.
2. Seed plots at the Hacienda San Antonio, Ilagan, Isabela, of the Compañia General de Tabacos de Filipinas, the biggest tobacco corporation in the Philippines.

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PLATE 27

1. Tobacco capsules of a single self-fertilized plant harvested for future planting.
2. A self-fertilized bunch of capsules of a single plant, cover just removed showing the immature pods which should be removed.

PLATE 28

1. Showing how the poles to support the cheese cloth flower bags, should be erected.
2. Showing how the flower heads are covered with cheese cloth bags.

PLATE 29

1. Typical leaves of the variety "Ilagan Sumatra."
2. Typical leaves of the variety "Simmaba" (Marogui).
3. Typical leaves of the variety "Vizcaya."

TEXT FIGURES

FIG. 1. A typical curing shed for wrapper tobacco in Sumatra.
2. A typical curing shed for wrapper tobbaco in Cuba.
3. Typical curing sheds for wrapper tobacco in the Connecticut Valley, U. S. A.
4. Method of sweating wrapper tobacco in the United States.
5. A method of piling wrapper tobacco in Sumatra for the fermentation process.
6. Diagram of a tobacco flower (longitudinal section).
7. Bags of tobacco seeds thoroughly cleaned ready for distribution.
8. Apparatus for cleaning tobacco seed.

PLATE 1.

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PLATE 2.

PLATE 3.

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PLATE 4.

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PLATE 5.

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PLATE 6.

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PLATE 7.

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PLATE 8.

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PLATE 9.

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PLATE 10.

PLATE 11.

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PLATE 12.

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PLATE 13.

PLATE 14.

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PLATE 15.

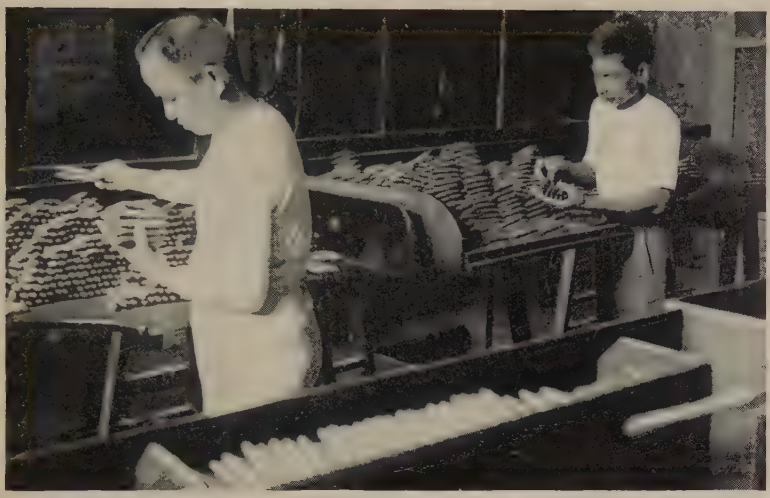

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PLATE 16.

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PLATE 17.

PLATE 18.

ESPECIALES
DIVINOS
SALOMONES
CULEBRAS
PERFECTOS
CONCHAS

PLATE 19.

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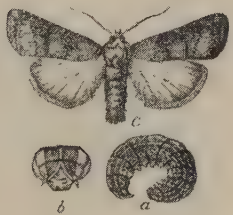

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PLATE 20.

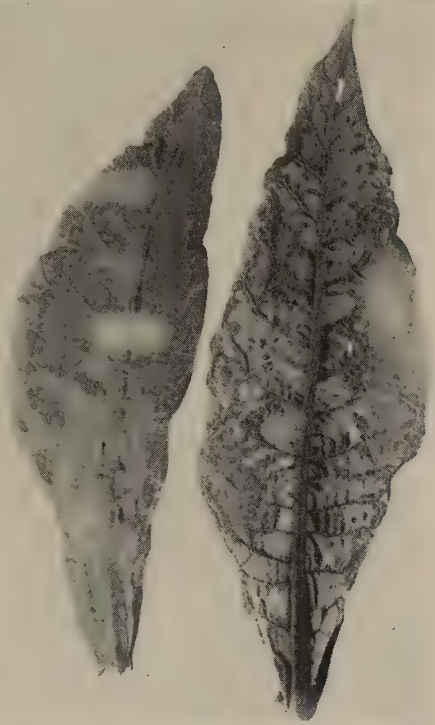

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PLATE 21.

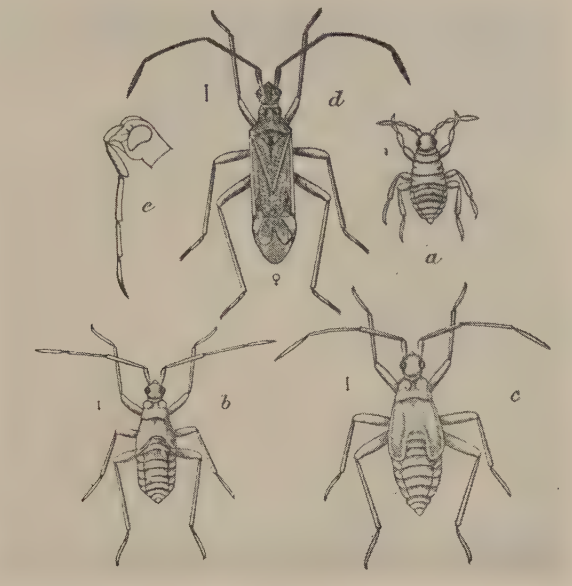

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PLATE 22.

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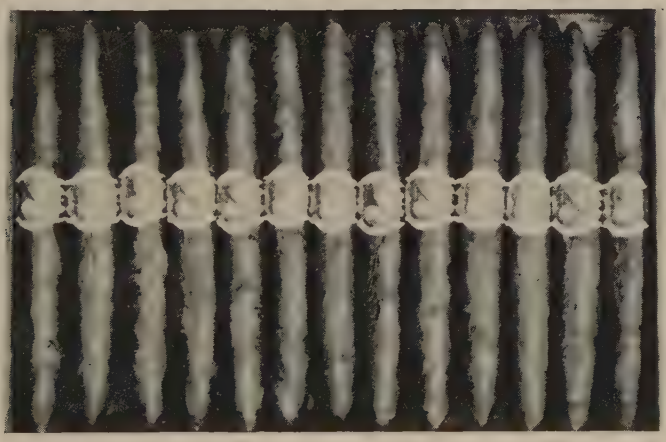

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PLATE 23.

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PLATE 24.

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PLATE 25.

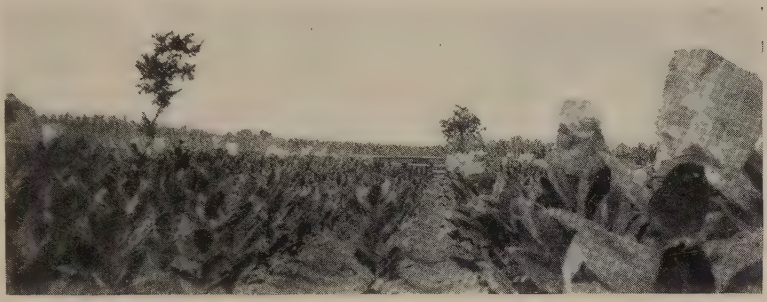

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PLATE 26.

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PLATE 27.

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PLATE 28.

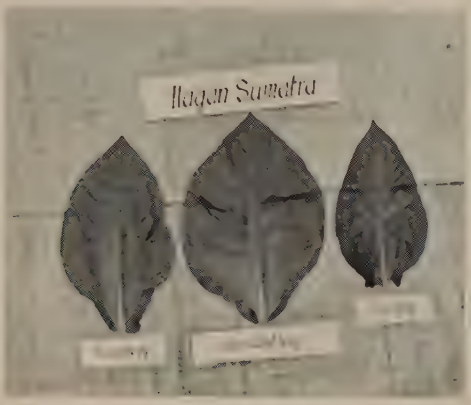

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PLATE 29.

A PROGRESS REPORT ON THE ACCLIMATIZATION OF CAULIFLOWERS, 1933-1934

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FIVE PLATES

Heretofore, the culture of cauliflower, *Brassica oleracea* var. *botrytis* Hort., in the Philippines has been confined to high elevations particularly in Baguio and Trinidad Valley, Mountain Province. There have been some isolated claims that cauliflower has been grown in the past at Fort William McKinley and at Morong, Rizal. However, the fact still remains that cauliflower, is, up to this writing, a new plant to gardeners in the City of Manila and its vicinity. And, even in Baguio and Trinidad Valley, the culture of cauliflower is limited. There, it is generally grown from November to February and only a few gardeners raise it in spite of the high price it commands in the market. The reason is that it is difficult to insure the production of the "curd," the edible portion of the plant. Besides, gardeners there claim that cauliflower is a delicate crop to handle.

The main object of this study was to find some varieties of cauliflower that can be grown at sea level under tropical climates, and simultaneously to find some fertilizer treatments that may favor "curd" formation.

This preliminary report deals with the results of the 1933-1934 studies on cauliflower which were undertaken at the Central Experiment Station, San Andres, Manila,[1] and at the Lipa Coffee-Citrus Station,[2] Lipa, Batangas. The test was started in October, 1933 and completed in July, 1934.

MATERIALS AND METHODS

The seeds used in this study were imported from the United States, India, and Germany. The seeds from the last two countries were sent by some seed houses in those countries for trial planting here. In Table 1 are listed the varieties of cauliflower tried and the country of their origin.

[1] Manila is at sea level, while Lipa has an elevation of about 1,050 feet above sea level.

TABLE 1.—*Showing the varieties of cauliflower tested and the country of origin*

Variety name	Country of origin	Station where tested	Remarks
Henderson's Snowball	U. S. A.	Lipa Coffee-Citrus Station	No germination.
Primosnow	U. S. A.	do	Do.
Snow King	U. S. A.	do	Do.
Early Patna	India	Central Experiment Station and Lipa Coffee-Citrus Station.	Good germination.
Blumenkohl Juwel	Germany	Lipa Coffee-Citrus Station	Poor germination.
Blumenkohl Riesen	Germany	do	Do.

At the Central Experiment Station, three sets of planting were made; the first, early dry season planting (October to January); the second, late dry season planting (February to April); and the third, early rainy season planting (April to July). The first planting was treated with three kinds of fertilizers—the first series was fertilized with ammonium sulphate, the second series with ammonium sulphate and double superphosphate, and the third series with a complete fertilizer (8.3–16.7–8.3).

Table 3 gives the rate of application and the amount of available elements.

TABLE 2.—*Showing the fertilizers used, the rate of application and the amount of available elements from each*

Series No.	Name of fertilizer	Rate per hectare	Available elements per hectare	Formula
		Kilo	*Kilo*	
A	Ammonium sulphate	500	N 103	
B	Ammonium sulphate	500	N 103	
	Double superphosphate	530	P_2O_5 206.7	8.3–16.7–0
C	Ammonium sulphate	500	N 103	
	Double superphosphate	530	P_2O_5 206.7	8.3–16.7–8.3
	Sulphate of potash	210	K_2O 102.9	

The second and third plantings were fertilized with nitrophoska (15–15–18) at the rate of 700 kilos per hectare. When the plants have recovered from the effect of transplanting, they were twice dressed with ammonium sulphate at the rate of 80 kilos per hectare.

At the Lipa Coffee-Citrus Station, Lipa, Batangas, two sets of planting were made, early dry season planting and late dry

season planting. Both plantings were fertilized with only ammonium sulphate at the rate of 400 kilograms per hectare. The plants were also dressed twice with ammonium sulphate at the rate of 80 kilograms per hectare.

Cauliflower seedlings were raised in the same way as cabbage seedlings are produced. The seeds were first sown thickly in seed boxes and later pricked in beds for better development. The seedlings were transplanted in the garden when they were from four to five weeks old.

In all plantings, the seedlings were set in two-row beds, 60 centimeters between the rows and 50 centimeters between the plants. Before planting, about two handfuls of well rotted stable manure were put into the holes made for the reception of the plants. Where commercial fertilizers were used, such fertilizers were mixed with the stable manure which was previously put in the holes before planting.

Care of the plants.—The plants were weeded and cultivated regularly. Watering was done so as to keep the soil always moist, as it is done in a cabbage field. The plants were also sprayed regularly with lead arsenate spray (7 table spoonfuls [levelful] of lead arsenate to every petroleum canful of water) so as to prevent cabbage worms from destroying the cauliflower. Cabbage worms were observed rather in abundance particularly during the late dry season planting.

EXPERIMENTS AND RESULTS

Tests at the Central Experiment Station.—As already stated, three tests were conducted at the Central Experiment Station at San Andres, Manila. The variety Early Patna was the only one used in these tests.

The first test had a very good stand, and the formation of "curd" was comparatively uniform irrespective of the fertilizers used. In the second test, the stand of the plants was also good but the formation of the curd was rather irregular. The last test had a fair stand but rainfall was rather excessive just before the heading stage. As a result the heading was rather irregular, the curd small and, as a rule, was prone to "rice" early.

Tables 3, 4, 5, and 6 present the data of the first test, and Table 7 the second and third tests. Table 3 gives some data on the effect of the different kinds of fertilizers on the number of days to head, while Table 4, on the number of days to ma-

turity. Table 6 gives the average yield per plant as affected by the different fertilizers.

TABLE 3.—*Showing the number of days from sowing to heading as affected by different fertilizers*

Value	Frequency distribution		
	Series A	Series B	Series C
Day			
54	0	0	1
57	1	2	1
60	1	0	1
63	13	23	17
66	25	37	34
69	77	96	99
72	46	36	32
75	41	34	27
78	23	7	18
81	6	2	4
84	4	1	2
Total	237	238	236
Mean	71.32±0.204	69.59±0.161	70.09±0.199
Standard deviation	4.659±0.144	3.687±0.114	4.521±0.140
Coefficient of variability	65.32±2.752	52.98±2.048	64.53±2.704

TABLE 4.—*Showing the number of days from sowing to the harvesting of "curd"*

Value	Frequency distribution		
	Series A	Series B	Series C
Day			
64	0	0	1
67	1	0	1
70	2	7	1
73	4	3	1
76	16	22	23
79	91	121	119
82	50	47	48
85	39	24	20
88	13	7	12
91	11	7	7
94	6	0	2
97	3	0	1
100	1	0	0
Total	237	238	236
Mean	81.934±0.217	80.191±0.166	80.670±0.180
Standard deviation	4.941±0.154	3.783±0.117	4.092±0.127
Coefficient of variability	6.230±0.193	4.720±0.146	5.080±0.153

TABLE 5.—*Showing the number of days from the time the "curd" appeared to date of harvesting as affected by different fertilizers*

Value	Frequency distribution		
	Series A	Series B	Series C
Day			
6	4	12	6
9	115	119	125
12	92	86	90
15	23	18	11
18	1	2	3
21	1	1	1
24	1	0	0
Total	237	238	236
Mean	10.886±0.103	10.512±0.102	10.512±0.094
Standard deviation	2.340±0.073	2.328±0.072	2.136±0.066
Coefficient of variability	2.280±0.061	2.213±0.068	2.031±0.060

TABLE 6.—*Showing the weight per head of cauliflower as affected by different fertilizers*

Value	Frequency distribution		
	Series A	Series B	Series C
gram			
35	0	1	2
66	4	6	4
97	23	15	6
128	23	20	23
159	41	26	42
190	38	42	49
221	34	47	28
252	33	34	28
283	17	22	31
314	10	12	12
345	7	5	4
376	5	4	3
407	2	2	1
438	0	1	2
469	0	1	1
Total	237	238	236
Mean	202.71±3.18	212.01±3.20	211.39±3.15
Standard deviation	72.23±2.25	73.16±2.26	71.61±2.23
Coefficient of variability	35.63±1.24	34.47±1.18	33.80±1.16

TABLE 7.—*Showing the weight per head of cauliflower in late dry season and early rainy season plantings at the Central Experiment Station, Manila, 1934.*

Value	Frequency distribution	
	Late dry season planting (Feb.–Apr., 1934)	Early rainy season planting (Apr.–July, 1934)
gram		
35	3	28
66	12	27
97	21	18
128	18	8
159	12	4
190	17	5
221	12	5
252	6	0
283	3	2
314	0	0
345		1
376		1
407		1
Total	104	100
Mean	147.84±4.12	99.17±5.12
Standard deviation	61.69±2.89	75.95±3.62
Coefficient of variability	41.70±2.26	76.50±5.35

Test at the Lipa Coffee-Citrus Station.—The first sowing was made in October, 1933. Unfortunately, the sowing was followed by an inclement weather and all the American varieties failed to germinate. Few seeds of the German varieties germinated and only a few of these were raised to transplanting size with some difficulty. The test, therefore, was mostly composed of the Indian variety, Early Patna. Few plants of the German varieties, Blumenkohl var. Juwel, and Blumenkohl var. Riesen reached maturity. These plants however, were not harvested; they were used for observation on cauliflower seed production. Table 8 presents some data on the yield of cauliflower in the two tests conducted at the Lipa Coffee-Citrus Station, Lipa, Batangas.

TABLE 8.—*Showing the weight per head of cauliflower in the early and late dry season plantings at the Lipa Coffee-Citrus Station*[1]

Value	Frequency distribution	
	Early dry season planting (Oct.–Jan.)	Late dry season planting (Feb.–Apr.)
gram		
35	1	1
66	4	1
97	8	5
128	10	4
159	16	5
190	15	7
221	21	10
252	26	5
283	24	7
314	28	2
345	26	7
376	11	7
407	7	5
438	6	5
469	1	1
500	6	0
531	0	0
562	0	0
Total	210	72
Mean	270.60±4.72	264.40±8.71
Standard deviation	97.96±3.03	108.50±6.10
Coefficient of variability	36.20±1.37	41.00±2.65

[1] The comparatively high yield was partly due to the over maturity of some of the heads when harvested.

Some observations on diseases.—During the formation of head or "curd," a certain disease was noticed which caused the discoloration of the "curd." Only a few plants of the first planting in Manila were affected by the disease; in the second and third plantings, more were affected. The disease seemed to be more serious in Lipa than in Manila. According to Dr. F. Clara of the Pathology Section of the Bureau of Plant Industry, the disease is caused by two organisms—one is a fungus and the other is a bacterium.

The disease, because of the nature of the infected curd, may be called cauliflower curd rot. The diseased portion, at first, appears as a tiny spot, brownish in color. This rotting advances rather rapidly in a more or less regular front over the curd and in advanced cases renders the curd useless for culinary purposes.

Some observations on flowering.—Some plants at the maturity of the head or "curd" were allowed to remain uncut. The object was to find the possibility of producing seeds of cauliflower under local conditions. The study which is still in progress was conducted at the Central Experiment Station, and at the Lipa Coffee-Citrus Station, Lipa, Batangas.

Most of the plants that were allowed to flower produced pods (see Plate 2) but these failed to produce any seed. In Lipa, however, two seeds were obtained; these were planted at the Central Experiment Station in Manila. At the present writing, the two plants were in flower. The result of this test together with a detailed study of the flower and the possible causes of the failure of the pods to produce seeds will be reported in a separate paper at a later date.

Propagation of cauliflower by slips.—The cauliflower is commercially propagated by seed. Upon harvesting the first crop, a few stubs were left by accident in the garden undisturbed after cutting the heads. These produced slips at their bases after a couple of days which looked like regular cauliflower seedlings. Upon examination it was found that some of these slips produced roots. Two small plots were planted with these cauliflower slips; one plot with rooted slips, and the other with slips without roots. Both plots gave 100 per cent stand and the plants attained normal size but they produced small heads, perhaps, because of the late season. Besides, most of the heads were attacked by some diseases which caused them to rot.

DISCUSSION OF RESULTS

The result of this study was significant; it has brought new information that should prove very interesting and valuable to gardeners in the lowland.

Tests at the Central Experiment Station.—The first test which was considered as the early dry season planting (sown on October 24, 1933, and transplanted on November 24, 1933) produced a normal crop of cauliflower comparable to those raised in Trinidad Valley, Mountain Province. The plants began to form head or "curd," in the average, from 69.59 $\pm$ 0.161 to 71.32 $\pm$ 0.204 days after sowing. The first head formation was observed 54 days after sowing the seed and the last was noticed after 84 days (see Table 3). The first head was harvested 64 days after sowing and the last head, after 100 days.

In an attempt to find some fertilizer treatments that would favor head formation, three series of plots (A, B, and C) were

run. Series A was fertilized with nitrogen alone, series B with nitrogen and phosphorous; and series C with nitrogen, phosphorous, and potash. The amount of nitrogen in all series was the same and so with phosphorous in the two series receiving it (see Table 2). As shown in Table 6, the kind of fertilizer applied practically did not affect head formation; the plants receiving different fertilizer treatments produced heads. It may be added in this connection that no plant failing to produce head in any series was noticed except those whose terminal buds were destroyed by worms. There was, however, some slight differences in weight per head in favor of series B (fertilized with nitrogen and phosphorous), and series C (fertilized with nitrogen, phosphorous and potash). Perhaps, the soil was only slightly deficient in phosphorous and potash. The average weight per head in Series A was 202.71 ± 3.18 grams; that in series B was 212.01 ± 3.20 grams; and that in series C was 211.39 ± 3.15 grams. There was practically no difference between Series B and C as to the average weight of head per plant (see Table 6).

The other two plantings at the Central Experiment Station (late dry season and early rainy season) did not give results as good as the early dry season planting. While the source of the nitrogen in the last two plantings was different from the early dry season planting, the difference in yield could not be attributed to it. For even in the last two tests where the fertilizers used were the same, the early rainy season planting gave less average yield. The average yield per plant was 211.39 ± 3.15 grams for the early dry season planting; 147.84 ± 4.12 grams for the late dry season planting; and 99.17 ± 5.12 for the early rainy season planting (see Tables 6 and 7). The difference between the different plantings were all mathematically significant. It was also observed that in the last two plantings, the heads even when not yet fully developed, were prone to "rice," particularly in the last planting. The quality of the product in the last two plantings was inferior to the first planting.

The difference in yield must have been mainly due to the climatic conditions particularly the temperature, and in the last planting, also the excessive rainfall. For according to Thompson,[2] the "cauliflower thrives best in a cool, moist climate," and

[2] Thompson, H. C. Vegetable crops. ix + 560 p. 60 fig. New York: McGraw-Hill Book Company (1931).

that its "head will not develop well in hot weather." In the early dry season planting (last part of October to early part of January) the temperature was low, being the coolest part of the year but during the late dry season planting (February to April) the weather was hot and dry. During the last planting (April to early part of July) the weather was still hot and the plants were further affected by the torrential rains in June and July.

Tests at the Lipa Coffee-Citrus Station.—Both the early and late dry season plantings produced normal crops of cauliflower (Early Patna variety). The few plants of the two German varieties, Juwel and Riesen, also produced normal heads. In the case of the Early Patna variety the average yield per plant was 270.60 ± 4.72 grams for the early dry season crop and 264.40 ± 8.71 grams for the late dry season (see Table 8). Like in the Central Experiment Station, the early planting produced more than the late dry season crop. However, in Lipa, the difference was not considered mathematically significant. The reason was perhaps, due to the slight change in temperature because of the high elevation (1,050 ft.) of the place.

Some observations on diseases.—While these were the first attempt to grow cauliflower at the Central Experiment Station, and at the Lipa Coffee-Citrus Station, it was surprising to observe some diseases attacking the young heads. The disease caused the rotting of the head. At first it appeared as a tiny brownish speck but which advanced quite rapidly in a more or less regular front. The infested head became blackish brown. The diseases reduced the value of the curd and in severe cases rendered it unfit for consumption.

This disease might become a limiting factor in cauliflower production here if no control measure could be evolved.

Some observations in flowering.—An attempt was made to let some of the plants to produce flowers and possibly seeds. The plants the heads of which were not cut produced flowers and pods (See Figs. 4 and 5) but with the exception of a plant of the variety Early Patna at the Lipa Coffee-Citrus Station which produced two seeds, all the plants failed to seed. The plants produced a good crop of pods but they did not produce seeds. Upon examination it was found that there was scarcity of pollen grains in most of the plants examined.

The use of slips for planting.—Cauliflower stubs that were not pulled up produced some slips. These were tested for their value as planting materials. The trial although very limited showed

some possibility that merits further study. The cauliflower slips if found suitable for planting will be handy for home gardens, where small but continuous plantings may be desired.

SUMMARY OF CONCLUSIONS

1. This report presents the results of one year study on the acclimatization and cultural treatment of cauliflower. This was the first successful attempt in the Philippines to grow cauliflower at sea level and at elevations lower than Baguio and the Trinidad Valley, Mountain Province. The variety that was found successful came from Calcutta, India, and its variety name is Early Patna.

2. Both the trial tests at the Central Experiment Station, Manila (sea level) and at the Lipa Coffee-Citrus Station, Lipa, Batangas (1,050 feet above sea level) produced normal crops of cauliflower. The highest average yield per plant in Manila was 212.01 ± 3.20 grams while in Lipa, it was 270.60 ± 4.72 grams. Also those planted during the cool months of October to January produced heavier heads than those planted later in the season.

3. The variety Early Patna began to form head, in the average of 69.59 ± 0.161 to 71.32 ± 0.204 days after sowing, and the heads were ready to be harvested in the average of 80.19 ± 0.166 to 81.33 ± 0.217 days after sowing. In other words, the Early Patna cauliflower matured in 80 days after sowing the seed when planted at sea level during the cool months of the year.

4. The plants which were fertilized with a complete fertilizer and a combination of nitrogen and phosphorous had the tendency to mature earlier and to produce heavier heads than those fertilized with nitrogen alone.

5. Other varieties that produced head besides the Early Patna at the Lipa Coffee-Citrus Station were two German varieties, Blumenkohl Juwel and Blumenkohl Riesen.

6. Several plants of the Early Patna, Blumenkohl Juwel and Blumenkohl Riesen varieties produced flowers and pods but failed to produce seeds except a plant of the Early Patna in Lipa which produced two good seeds. Many flowers produced in Manila when examined were found to have few or no pollen grains at all.

7. A preliminary study on the use of slips for planting purposes showed some possibility for such use in home gardens where small but more or less continuous plantings are desired. The plants were big and vigorous but the head were small perhaps because of the hot weather.

ILLUSTRATIONS

PLATE 1

A cauliflower plantation at the Central Experiment Station, San Andres, Manila. The cauliflower plots are those marked (X). Note the size of the plants and their narrow leaves as compared with the cabbage plants in between.

PLATE 2

Showing some cauliflower heads or "curd" (Early Patna). These represent the first harvest at the Central Experiment Station, San Andres, Manila.

PLATE 3

A cauliflower head showing its well advance "rice" stage. Note the flower stalks.

PLATE 4

A cauliflower inflorescence with some flowers about to open.

PLATE 5

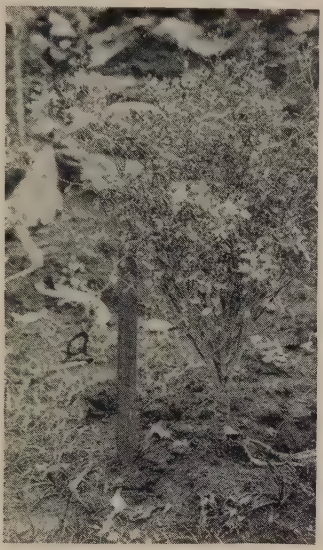
Some cauliflower plants in full bloom. Note the numerous flowers in fig. 1 and the developing pods in figs. 1 and 2.

PLATE 1.

PLATE 2.

PLATE 3.

PLATE 4.



1

2

PLATE 5.

THE RELATION OF FRUITING TO VEGETATIVE GROWTH CHARACTERS IN CARABAO MANGO, *MANGIFERA INDICA* L.

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TWO TEXT FIGURES

Considerable interest has been manifested in the relation between the fruit bud formation and the vegetative growth of the plant. But so far not much data upon the possible relationship have been obtained, except on a few temperate fruit trees. To improve the yield of a tree it is necessary to find out the relation existing between its various parts and its fruiting ability, that is, if certain distinguishable growth characters are associated with the production of fruits. To accomplish this the vegetative growth of the tree should be thoroughly studied and measured. To know the desirable qualities and the vegetative growths which influence the fruiting of a tree is a safe criterion to be followed in improving that tree either by breeding or by cultural methods. For according to Collins (1) nearly all successful breeding has been made possible by the fact that correlations exist. And if the study of correlations has appeared to have little bearing on plant breeding, it must be that we have studied the wrong characters or studied them in the wrong way, he said. In formulating the ideal type, however, a distinction is also to be made between characters which do not bear the qualities sought, but are only supposed to have some fundamental bearing with their development. And before making distinctions of these characters it is essential to ascertain first the relative merits of the mutually exclusive characters of the different parts—leaves, stems, and roots—of the plant, and whether the bearing quality is really dependent upon a particular character or a combination of such characters. The immediate objective of the present study, therefore, was to determine the relationship between the growth characters of the shoot and the fruiting of the Carabao mango, *Mangifera indica* L., and, if correlation exists, then growth measurements are in order so as to enable us to point out definitely such desirable characters.

Available literature pertaining to this subject is scant. But according to Robert (2) an increase in diameter of the wood of apple trees due to the laying down of reserve materials is favorable to blossom formation, and shoots and spurs having intermediate length are where the fruit buds are most readily formed, while the shortest spurs rarely produced fruit buds, and many of the longest spurs had terminal leaf buds. Moreover, fruitfulness was associated with the thickness of the shoots, or regular bearing was related to wood growth. Kraus and Kraybill (3) obtained an identical result on tomato plant. Crow and Edit (4) suggested the possibility of the growth in diameter as an index of flower bud formation. Roberts, again, found that when the overvegetative apple tree produced growth with a thick diameter (in relation to length of growth) it became fruitful. Gardner (5) believes that there is a close correlation between increase in trunk circumference at any period and the leaf area possessed by the tree at that particular time.

As regards the growing of the leaves, Gourley (6) has suggested that large leaf surface is associated with fruit bud formation. Magness (7) said that the fruit-bud initiation of the apple will not take place, and fruit bud will not form in most varieties in the absence of a fair amount of leaf-area in the tree. And the leaf area in one part of the tree will usually not supply food material to the buds in another part to the extent necessary to cause them to become fruit buds. Roberts (2) found that the longer the spurs were the more number of leaves there were and the leaf area was greatly increased. And that biennial bearing was related to spur growth and was more so during the off season, and regular bearing was related to wood-growth and there was more growth in the regular bearing tree than on the biennial bearing tree. This again proved that fruitfulness was better on trees which made an intermediate growth. The same author reported that from 48.8 to 54.3 per cent of the shoots with larger leaves flowered against 0.5 to 4.1 per cent of the shoots having small terminal leaves. On the other hand, Kraybill et al. (8) reported that the leaf area in square inches per spur of the apple tree was highest on the nonfruiting spurs of the nitrogen plot, lowest on the fruiting spurs on the sod plot, and approximately equal and intermediate on the nonfruiting spurs of the sod plot and the fruiting spurs of the nitrogen plot. However, the bearing spurs of the sod plot, which formed no fruit buds whatever, uniformly showed the smallest leaf area.

From his finding, therefore, it appears that there is, in general, a tendency to produce more flowers as the leaf area increases. Rapidly growing plants rarely form many flower buds because the food is used in growth as fast as they are formed, and the size of the leaves depends much on the water supply during their formation while the growth of the stem and roots depends upon the number of leaves, according to Goff (9). There is a correlation between the number of leaves and the development of the fruit. A certain number of leaves are necessary for the proper development of the fruit and the greater the leaf area per fruit, the greater the total size of the fruit produced, although the increase in size of the fruit is not in proportion to the increase in foliage according to Magness, et. al (10). Hayes and Garber (11) pointed out that the yield of plant, particularly of wheat and oats, is the result of many growth factors, but in general no one character is closely associated with yield, at least to such an extent as to be of selection value in picking out high yielding strains.

MATERIALS AND METHODS

The materials used in this study consisted of seedling and vegetatively grown Carabao mango trees of various fruiting ages growing in Bataan and Pampanga. The districts covered by this study are good representative mango districts having a distinct dry and rainy season favorable to the fruiting of mango. The Carabao mango is the most important mango variety grown in the Philippines; it is reputed to surpass the flavor and quality of all the other varieties found under cultivation here and elsewhere. Both heavy-bearing and light-bearing trees under similar soil and climatic conditions were studied, and some old non-bearing trees were observe as check. The parts included in the study were the length and diameter of the bearing and non-bearing trees were observed as check. The parts included growths, and the dimension and the number of their leaves. Inasmuch as the flowers of the mango are in the majority of cases produced on the previous season's growth, the present observations have been confined to this portion of the branches.

In all cases the length of the portion of the twigs studied was taken from the tip to the basal end and the diameter at the middle portion of each shoot (Fig. 1). Both length and width measurements of leaves were taken from a number of representative twigs. The petioles were excluded from the measurements

(Fig. 2). The leaves of all the twigs measured were counted and numbered 137,788 in all. Measurements were taken from 6,628 bearing and 8,716 non-bearing terminal and lateral shoots and 5,830 leaves of 34 bearing trees and 10 non-bearing robust and unthrifty trees. Terminal as well as lateral shoots were studied. Twigs and leaves on four quadrants of the trees—north, south, east, and west—were measured and counted in order to eliminate the possible influence of light and wind velocity, if any. Twigs that have fruited or flowered were considered bearing, and all others non-bearing. The shoots were classified as terminal if they originated from terminal buds and lateral if from the axillary buds.

FIG. 1.

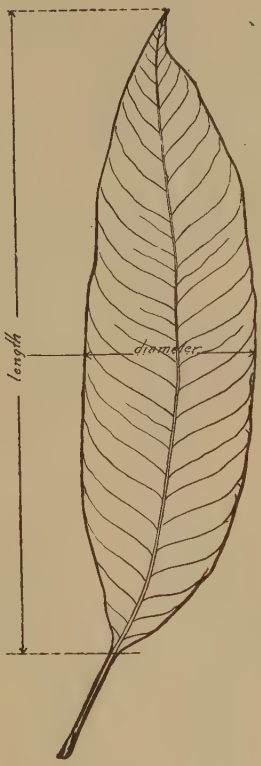

FIG. 2.

The mean and the difference of the growths of the fruiting and non-fruiting shoots were calculated and determined by using Babcock and Clausen formulæ. The results of these computations are presented in Tables 1, 2, and 3.

DISCUSSION OF RESULTS

The materials used were of different strains some of which were grown vegetatively and others from seedling trees, and the observations covered only one fruiting season. If the trees studied were originated from a pure and vegetatively grown strain a reliable measure of the behavior of the trees may be expected. But there were no such trees available for study. However, the results obtained are believed sufficiently interesting

to warrant their publication. They may serve as guide in the proper cultural treatment and care of the Carabao mango tree. The results show among other things that there is a positive difference between the length and diameter of the shoots, and the number and area of the leaves of the bearing and non-bearing Carabao mango trees. The fruiting ability of the Carabao mango tree, therefore, seems to be dependent upon the growth of its twigs and leaves.

Considering the bearing tree as a whole, the bearing terminal as well as the lateral twigs were longer and greater in diameter than the non-bearing twigs. There were slightly more but smaller, leaves on the bearing than on the nonbearing shoots (see Table 1).

From Table 2 it is interesting to note that the terminal as well as the lateral twigs of the nonbearing robust trees were longer, larger and had smaller and more leaves than the twigs of the bearing trees. On the other hand, Table 3 shows that the growth characters of the nonbearing unthrifty trees, also at bearing age, were much less than those of the bearing trees both in length and in diameter of the twigs, and the number and area of the leaves. In this connection it may be stated that a mango twig, in order to have the greatest chance of producing flowers, has to attain a length of 14.23 $\pm$ 0.0113 cm. and a diameter of 6.25 $\pm$ 0.0021 mm., and with a total of 10.47 $\pm$ 0.0060 leaves measuring 94.67 $\pm$ 0.2013 sq. cm. each. Deviations from these figures, either downward or upward, as may be seen from Tables 1 to 3, seem to lessen in a direct proportion the chance for the twig to flower. Even taking into consideration the twigs at the different quadrants of the bearing and nonbearing trees to find if these growth characters are influenced either by the wind or morning and afternoon sun, it has been observed that the same relationship exists as shown in Tables 4 to 6. For instance, Table 4 shows that the bearing terminal as well as the lateral twigs of the bearing trees in all directions exhibited longer, larger and slightly more leaves but generally less total leaf area than the nonbearing twigs; Table 5, shows that the twigs of the nonbearing robust trees were longer, bigger and contain more leaves and of greater total leaf area than the bearing twigs; and Table 6, shows that the twigs of the nonbearing unthrifty trees were shorter and generally smaller in diameter and with less total number and area of leaves, than bearing twigs.

CONCLUSIONS

From the observations made there seems to be little doubt that the growth characters of the shoots and the number and area of the leaves of the Carabao mango tree are associated with its fruiting ability. The following conclusions may be deduced from the foregoing data:

1. There is a relation between the length and diameter of the twigs with fruiting. It is apparent that in the case of the nonbearing robust trees in this test there were an abundance of vegetative growths of the twigs—length and diameter—compared with the bearing trees. On the other hand, the average length and diameter of the twigs were less on the nonbearing unthrifty trees than on the bearing trees, except in a few cases where the diameter was a little more than those of the bearing twigs.

2. There is a relation between the leaf area and the number of leaves with fruiting. As the number of leaves increases, each with a less leaf area, the less fruitful the tree becomes as in the case of the nonbearing robust trees. On the other hand, as they diminish both in number and dimension as in the case of the non-bearing unthrifty trees the less the trees become fruitful.

3. In the case of the bearing trees the average length and diameter of the bearing twigs were greater than those of the nonbearing twigs. And also there were more leaves but with less leaf area.

TABLE I.—*Showing the difference between the bearing and the nonbearing twigs*

Parts	Bearing trees			
	Mean of bearing twigs	Mean of nonbearing twigs	Difference	Significance (5×P.E.D.)
Terminal shoots:				
Length of twigs in cm.	14.23±0.0113	12.56±0.0101	1.67±0.0151	Significant.
Diameter of twigs in mm.	6.25±0.0021	5.87±0.0024	0.38±0.0031	Do.
Number of leaves	10.47±0.0060	10.16±0.0060	0.31±0.0084	Do.
Area of leaves in sq. cm.	94.67±0.2013	99.99±0.3074	5.32±0.3674	Do.
Lateral shoots:				
Length of twigs in cm.	14.62±0.0094	13.88±0.0099	0.74±0.0136	Do.
Diameter of twigs in mm.	5.35±0.0020	5.16±0.0030	0.19±0.0036	Do.
Number of leaves	7.30±0.0059	7.19±0.0071	0.11±0.0092	Do.
Area of leaves in sq. cm.	84.59±0.0651	86.15±0.3172	1.56±0.3237	Doubtful.

TABLE II.—*Showing the difference between bearing twigs and twigs of non-bearing robust trees*

Parts	Mean of bearing twigs	Mean of twigs of nonbearing robust trees	Difference	Significance (5×P.E.D.)
Terminal shoots:				
Length of twigs in cm.	14.23±0.0113	19.14±0.1804	4.91±0.1807	Significant.
Diameter of twigs in mm.	6.25±0.0021	7.30±0.0099	1.05±0.0101	Do.
Number of leaves	10.47±0.0060	14.01±0.0270	3.54±0.0276	Do.
Area of leaves in sq. cm.	94.67±0.2013	88.98±0.1663	5.69±0.2611	Do.
Lateral shoots:				
Length of twigs in cm.	14.62±0.0094	23.47±0.0484	8.85±0.0493	Do.
Diameter of twigs in mm.	5.35±0.0020	6.97±0.0442	1.62±0.0442	Do.
Number of leaves	7.30±0.0059	10.63±0.1140	3.33±0.1141	Do.
Area of leaves in sq. cm.	84.59±0.0651	74.67±0.2082	9.92±0.2181	Do.

TABLE III.—*Showing the difference between bearing twigs and twigs of nonbearing unthrifty trees.*

Parts	Mean of bearing twigs	Mean of twigs of nonbearing unthrifty trees	Difference	Significance (5×P.E.D.)
Terminal shoots:				
Length of twigs in cm.	14.23±0.0113	7.05±0.0311	7.18±0.0330	Significant.
Diameter of twigs in mm.	6.25±0.0021	6.11±0.0248	0.14±0.0248	Do.
Number of leaves	10.47±0.0060	9.94±0.0217	0.53±0.0225	Do.
Area of leaves in sq. cm.	94.67±0.2013	46.88±0.1503	47.79±0.2512	Do.
Lateral shoots:				
Length of twigs in cm.	14.62±0.0094	8.43±0.0343	6.19±0.0355	Do.
Diameter of twigs in mm.	5.35±0.0020	5.37±0.0068	0.02±0.0070	Insignificant.
Number of leaves	7.30±0.0059	6.95±0.0234	0.35±0.0241	Significant.
Area of leaves in sq. cm.	84.59±0.0651	44.99±0.1393	39.60±0.1537	Do.

TABLE IV.—*Showing difference by direction between bearing and nonbearing twigs of bearing trees*

Parts	Bearing trees			
	Mean of bearing twigs	Mean of nonbearing twigs	Difference	Significance) (5×P.E.D.
Terminal shoots:				
Length of twigs in cm.	14.18±0.0467	12.27±0.0429	1.91±0.0634	Significant.
Diameter of twigs in mm.	6.28±0.0087	5.95±0.0366	0.33±0.0376	Do.
Number of leaves	10.38±0.0250	10.03±0.0253	0.35±0.0355	Do.
Area of leaves in sq. cm.	91.53±0.0892	98.22±1.1713	6.69±1.1720	Do.
Lateral shoots:				
Length of twigs in cm.	14.61±0.0391	13.94±0.0412	0.67±0.0568	Do.
Diameter of twigs in mm.	5.53±0.0061	5.36±0.0138	0.17±0.0150	Do.
Number of leaves	7.22±0.0198	7.05±0.0204	0.17±0.0284	Do.
Area of leaves in sq. cm.	86.08±0.1051	83.36±0.6345	2.72±0.6431	Doubtful.
North terminal shoots:				
Length of twigs in cm.	14.21±0.0402	12.10±0.0362	2.11±0.0540	Significant.
Diameter of twigs in mm.	6.28±0.0074	5.94±0.0069	0.34±0.0101	Do.
Number of leaves	10.53±0.0239	9.88±0.0199	0.65±0.0311	Do.
Area of leaves in sq. cm.	90.03±0.0425	90.36±0.6008	0.33±0.6023	Insignificant.
North lateral shoots:				
Length of twigs in cm.	14.73±0.0322	13.41±0.0401	1.32±0.0514	Significant.
Diameter of twigs in mm.	5.56±0.0074	5.33±0.0076	0.23±0.0106	Do.
Number of leaves	7.39±0.0228	6.78±0.0159	0.61±0.0277	Do.
Area of leaves in sq. cm.	88.03±0.0831	89.44±1.3259	1.41±1.3285	Insignificant.
West terminal shoots:				
Length of twigs in cm.	14.25±0.0368	12.75±0.0364	1.50±0.0517	Significant.
Diameter of twigs in mm.	6.30±0.0389	5.74±0.0071	0.56±0.0395	Do.
Number of leaves	10.17±0.0243	10.26±0.0241	0.09±0.0342	Insignificant.
Area of leaves in sq. cm.	94.85±0.0883	113.95±1.0850	19.10±1.0885	Significant.
West lateral shoots:				
Length of twigs in cm.	15.21±0.0318	13.79±0.0263	1.42±0.0412	Do.
Diameter of twigs in mm.	5.24±0.0090	5.24±0.0053	----------	Do.
Number of leaves	7.27±0.0191	7.11±0.0232	0.16±0.0300	Significant.
Area of leaves in sq. cm.	86.40±0.0403	88.82±1.1353	2.43±1.1360	Insignificant.
South terminal shoots:				
Length of twigs in cm.	14.29±0.0344	13.51±0.0358	0.78±0.0496	Significant.
Diameter of twigs in mm.	6.38±0.0097	6.40±0.0096	0.02±0.0136	Insignificant.
Number of leaves	10.68±0.0243	10.67±0.0248	0.01±0.0347	Do.
Area of leaves in sq. cm.	100.45±0.1077	104.49±1.8609	4.04±1.8095	Do.
South lateral shoots:				
Length of twigs in cm.	14.75±0.0333	14.59±0.0318	0.16±0.0460	Doubtful.
Diameter of twigs in mm.	5.47±0.0066	5.06±0.0058	0.41±0.0087	Significant.
Number of leaves	7.49±0.0233	7.46±0.0225	0.03±0.0323	Insignificant.
Area of leaves in sq. cm.	75.37±0.2737	83.32±0.7722	7.95±0.8192	Significant.

TABLE V.—*Showing difference by direction between bearing twigs and twigs of nonbearing robust trees*

Parts	Mean of bearing twigs	Mean of twigs of nonbearing robust trees	Difference	Significance (5×P.E.D.)
East terminal shoots:				
Length of twigs in cm.	14.18±0.0467	20.67±0.2256	6.49±0.2303	Significant.
Diameter of twigs in mm.	6.28±0.0087	7.53±0.0236	1.25±0.0251	Do.
Number of leaves	10.38±0.0250	15.00±0.3479	4.62±0.3488	Do.
Area of leaves in sq. cm.	91.53±0.0892	94.31±0.5364	2.78±0.5437	Do.
East lateral shoots:				
Length of twigs in cm.	14.61±0.0391	23.46±0.2624	8.85±0.2652	Do.
Diameter of twigs in mm.	5.53±0.0061	7.23±0.0529	1.70±0.0532	Do.
Number of leaves	7.22±0.0198	11.28±0.1211	4.06±0.1227	Do.
Area of leaves in sq. cm.	86.08±0.1051	77.27±0.4661	8.81±0.4778	Do.
North terminal shoots:				
Length of twigs in cm.	14.21±0.0402	18.83±0.1637	4.62±0.1685	Do.
Diameter of twigs in mm.	6.28±0.0074	7.38±0.0391	1.10±0.0397	Do.
Number of leaves	10.53±0.0239	13.86±0.1083	3.33±0.1109	Do.
Area of leaves in sq. cm.	90.03±0.0425	94.22±0.5303	4.19±0.5320	Do.
North lateral shoots:				
Length of twigs in cm.	14.73±0.0322	23.48±0.5275	8.75±0.5284	Do.
Diameter of twigs in mm.	5.56±0.0074	7.10±0.4114	1.54±0.4114	Doubtful.
Number of leaves	7.39±0.0228	10.34±0.1056	2.95±0.1080	Significant.
Area of leaves in sq. cm.	88.03±0.0831	77.17±0.5448	10.86±0.5511	Do.
West terminal shoots:				
Length of twigs in cm.	14.25±0.0368	18.72±0.6444	4.47±0.6454	Do.
Diameter of twigs in mm.	6.30±0.0389	7.33±0.0340	1.03±0.0516	Do.
Number of leaves	10.17±0.0243	14.62±0.1062	4.45±0.1085	Do.
Area of leaves in sq. cm.	94.85±0.0883	88.08±0.4152	6.78±0.4244	Do.
West lateral shoots:				
Length of twigs in cm.	15.21±0.0318	22.62±0.1679	7.41±0.1708	Do.
Diameter of twigs in mm.	5.24±0.0090	6.74±0.0503	1.50±0.0503	Do.
Number of leaves	7.27±0.0191	10.32±0.0980	3.05±0.0998	Do.
Area of leaves in sq. cm.	86.40±0.0403	60.99±0.3014	25.41±0.3040	Do.
South lateral shoots:				
Length of twigs in cm.	14.29±0.0344	18.04±0.1872	3.75±0.1903	Do.
Diameter of twigs in mm.	6.38±0.0097	6.98±0.0385	0.60±0.0397	Do.
Number of leaves	10.68±0.0243	12.31±0.1224	1.63±0.1247	Do.
Area of leaves in sq. cm.	100.45±0.1077	82.92±0.4434	17.53±0.4562	Do.
South lateral shoots:				
Length of twigs in cm.	14.75±0.0333	23.84±0.5672	9.09±0.5681	Do.
Diameter of twigs in mm.	5.47±0.0066	6.82±0.0492	1.35±0.0496	Do.
Number of leaves	7.49±0.0233	10.31±0.0998	2.82±0.1024	Do.
Area of leaves in sq. cm.	75.37±0.2737	86.44±0.7601	11.07±0.8078	Do.

TABLE VI.—*Showing difference by direction between bearing twigs and twigs of nonbearing unthrifty trees*

Parts	Mean of bearing twigs	Mean of twigs of nonbearing unthrifty trees	Difference	Significance (5×P.E.D.)
East terminal shoots:				
Length of twigs in cm.	14.18±0.0467	7.08±0.0865	7.10±0.0983	Significant.
Diameter of twigs in mm.	6.28±0.0087	6.38±0.0312	0.10±0.0323	Doubtful.
Number of leaves	10.38±0.0250	9.33±0.1096	1.05±0.1124	Significant.
Area of leaves in sq. cm.	91.53±0.0892	49.62±0.4616	41.91±0.4701	Do.
East lateral shoots:				
Length of twigs in cm.	14.61±0.0391	8.71±0.1401	5.90±0.1454	Do.
Diameter of twigs in mm.	5.53±0.0061	5.68±0.0183	0.15±0.0174	Do.
Number of leaves	7.22±0.0198	7.18±0.0761	0.04±0.0786	Insignifidant.
Area of leaves in sq. cm.	86.08±0.1051	57.60±0.4782	29.02±0.4896	Significant.
North terminal shoots:				
Length of twigs in cm.	14.21±0.0402	6.36±0.1219	7.85±0.1283	Do.
Diameter of twigs in mm.	6.28±0.0074	5.84±0.0172	0.44±0.0187	Do.
Number of leaves	10.53±0.0239	8.40±0.0722	2.13±0.0760	Do.
Area of leaves in sq. cm.	90.03±0.0425	47.10±0.6058	42.93±0.6072	Do.
North lateralshoots:				
Length of twigs in cm.	14.73±0.0322	8.17±0.1034	6.56±0.1082	Do.
Diameter of twigs in mm.	5.56±0.0074	5.24±0.0281	0.32±0.0290	Do.
Number of leaves	7.39±0.0228	6.52±0.0969	0.87±0.0995	Do.
Area of leaves in sq. cm.	88.03±0.0831	40.45±0.2699	47.58±0.2884	Do.
West terminal shoots:				
Length of twigs in cm.	14.25±0.0368	7.92±0.1159	6.33±0.1216	Significant.
Diameter of twigs in mm.	6.30±0.0389	6.24±0.0306	0.06±0.0494	Insignificant.
Number of leaves	10.17±0.0243	11.36±0.0983	1.19±0.1012	Significant.
Area of leaves in sq. cm.	94.85±0.0883	41.01±0.3437	53.84±0.3548	Do.
West lateral shoots:				
Length of twigs in cm.	15.21±0.0318	9.17±0.1160	6.04±0.1202	Do.
Diameter of twigs in mm.	5.24±0.0090	5.27±0.0192	0.03±0.0212	Insignificant.
Number of leaves	7.27±0.0191	6.89±0.0740	0.38±0.0764	Significant.
Area of leaves in sq. cm.	86.40±0.0403	40.57±0.3413	45.83±0.3436	Do.
South terminal shoots:				
Length of twigs in cm.	14.29±0.0344	6.70±0.1265	7.59±0.1310	Do.
Diameter of twigs in mm.	6.38±0.0097	5.97±0.0091	0.41±0.0133	Doubtful.
Number of leaves	10.68±0.0243	10.34±0.1043	0.34±0.1070	Do.
Area of leaves in sq. cm.	100.45±0.1077	50.92±0.4539	49.53±0.4665	Significant.
South lateral shoots:				
Length of twigs in cm.	14.75±0.0333	8.51±0.1352	6.24±0.1392	Do.
Diameter of twigs in mm.	5.47±0.0066	5.34±0.0186	0.13±0.0197	Do.
Number of leaves	7.49±0.0233	7.37±0.0083	0.12±0.0247	Do.
Area of leaves in sq. cm.	75.37±0.2737	41.56±0.4266	33.81±0.5068	Do.

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QUARTERLY NOTES

THE THIRD PHILIPPINE SCIENCE CONVENTION

Under the auspices of the National Research Council of the Philippine Islands and the Philippine Scientific Society, about 200 scientists of the Government, local institutions of learning and private laboratories met in convention from February 26 to March 2, 1935.

The Convention was opened by Dr. Manuel L. Roxas, formerly Under Secretary of Agriculture and Commerce and Commissioner of Research, Chairman of the Natural Research Council. In his opening address, Doctor Roxas made a brilliant defense of the scientific research work in the Philippines, emphasizing the need for "a better understanding of the nature and purposes of research by our lay officials." He urged more support for scientific research, saying: "However viewed in any angle, I can say without fear of successful contradiction that the means which have been placed in the hands of our scientists have been woefully inadequate. Unless this sad state of affairs is remedied progress will remain slow."

Acting Governor-General J. R. Hayden who addressed the Convention expressed that scientific achievement is a good way for a small nation to win the respect and protection of stronger nations. He gave Belgium as an example of a small nation respected for the work of her scientists.

Dr. Jorge Bocobo, President of the University of the Philippines, lauded the progress attained by local scientists in the different branches of science in recent years. He said: "Glancing over the great and wide range of scientific topics discussed by the many papers to be read, one can not but observe the great strides made in recent years in the Philippines in regard to scientific research in all branches of science. Such a convention as this, with such evidence of the scientific spirit in many lines, could not have been possible twenty years ago."

Other notables who addressed the Convention were the Hon. Eulogio Rodriguez, Secretary of Agriculture and Commerce, Mr. Joaquin M. Elizalde, President of the Philippine National Development Company, and Professor H. H. Bartlett, Head of the Department of Botany, University of Michigan and Exchange Professor of Botany, University of the Philippines.

Secretary Rodriguez advised greater emphasis on applied science and quoting Emerson, he said that something is lacking in science until it has been humanized.

"Scientific treatises couched in scientific language are useful and understandable among yourselves who are scientists and who speak the same language," he stated, "but are of no practical benefit to the farmers. It is only when they are shorn of the veil of technicality, it is only when they are brought and simplified to within the understanding of the men in

the fields that they are of real usefulness." He said that scientists can be the instrument of redemption of the Philippines at this time when its salvation lies in economics. "You can perform this rôle," he added, "by transforming scientific abstractions to practical realities."

In its business meetings the following resolutions were approved: (1) Resolution on library facilities for research; (2) resolution requesting the Third Science Convention to coöperate in promoting, coördinating and enlarging the present activities of the National Committee on mental hygiene; (3) resolution recommending resumption of the policy of sending advanced students for specialized training; (4) resolution petitioning the President and the Board of Regents of the University of the Philippines for the continuance and increase of its support to research in the University; (5) resolution placing on record the need of setting aside funds for investigations on water power development; and (6) resolution adhering to the policy of maintaining one central scientific library.

On February 28, the National Research Council held its annual election of officers, the result of which was as follows:

EXECUTIVE BOARD

Dr. Manuel L. Roxas, Member-at-Large and Chairman.
Dr. Angel S. Arguelles, Member-at-Large and Vice-Chairman.
Dr. Bienvenido M. Gonzales, Member-at-Large.
Dr. Patrocinio Valenzuela, Executive Secretary and Treasurer.

Chairman of Divisions

Dr. Victor Buencamino, Chairman, Division of Government, Foreign and Educational Relations.
Dr. Leopoldo A. Faustino, Chairman, Division of Physical and Mathematical Sciences.
Dr. Antonio G. Sison, Chairman, Division of Medical Sciences.
Dr. Amando Clemente, Chairman, Division of Chemical and Pharmaceutical Sciences.
Dr. Eduardo Quisumbing, Chairman, Division of Biological Sciences.
Dir. Jose S. Camus, Chairman, Division of Agriculture and Forestry.
Prof. Hermenegildo B. Reyes, Chairman, Division of Enginering and Industrial Research.

On March 2, the Philippine Scientific Society also held its election of officers, which resulted as follows:

Dr. Eduardo Quisumbing, President
Dr. Arturo Garcia, Vice-President
Dr. Patrocinio Valenzuela, Secretary-Treasurer
Dr. Manuel L. Rozas, Councilor
Dir. Jose S. Camus, Councilor
Dr. Francisco O. Santos, Councilor

BUREAU OF PLANT INDUSTRY REORGANIZATION

Secretary Eulogio Rodriguez approved the plan of reorganization of the Bureau of Plant Industry proposed by Director Jose S. Camus of the said Bureau.

The salient points of the reorganization effected are as follows:

(1) The varied and extensive activities of the Buerau are carried on along the lines of divisional organization, so that the specialists or scientists in different lines of activities may be better developed and more properly grouped together to serve the best interest of the farmers.

(2) The different scientists or specialists who have been given assignments other than their particular specialization, were reassigned to their respective lines of specialty. Likewise, the different sections that properly belong to definite divisions were also restored whenever practicable and every phase of activity so coördinated and systematized as to bring about immediate and more positive results.

(3) Every agronomical district was assigned under a man who is conversant with the different agricultural problems of the district, possessed of a good knowledge of crops and their requirements, acquainted with pathological and entomological work, and in brief, fully fitted to assume the task of rural leadership. Close contact of the Bureau to farms will always be maintained.

(4) The agricultural engineering activity is revived. Agricultural engineering work covers such problems as proper irrigation and drainage, particularly for small farmers, soil reclamation, the use of agricultural machinery and implements, terracing and the conservation of soil fertility, all of which are very important, especially at this time when we need to improve our farm practices to reduce cost of production and improve the quality of the products. These problems are given much attention in other countries as Java, Sumatra and British Malaya, but receives little attention in this country.

(5) A committee on crop survey composed of some of the best trained men of the Bureau was created for the purpose of studying the proper kinds of temporary and permanent crops recommendable for planting in different sections of the Islands, particularly in the specialized agricultural regions such as the sugar cane, coconut and abaca producing provinces. This is in connection with the crop diversification drive which is presently being conducted to increase the source of farm income and make up for the crops affected by limitation.

(6) Greater emphasis is placed on the industrialization of agricultural products such as the abaca sack weaving and rug manufacture from abaca fibers; coconut by-product manufacture as well as door-mat weaving from coconut coir; cotton cloth and miscellaneous fiber weaving; and cassava flour and starch manufacture. In this industrialization work emphasis is laid on the production of those imported products for which enormous sums

of money are drained from the country but a majority of which if not all could be produced in the Islands. The ultimate aim is to make the country self-sufficient and then to be able to export the surplus.

(7) The various research activities of the Bureau are intensified and so adjusted and coördinated as to center first of all on the fundamental problems of the major agricultural industries with the aim in view of producing results that would be of the greatest practical value to the country within the shortest time possible. Simplification of the experiments on the urgent crop problems conducted with the utmost economy to the administration are always borne in mind.

(8) More effective help will be rendered to the farmers through a systematic prgram of demonstraion and publicity on improved farm practices in general.

The reorganization involved a shuffling or realignment of personnel to conform to the objective or rendering a more systematic, efficient and effective service to the public.

ILLUSTRATION

Chart showing present organization of the Bureau of Plant Industry.

ORGANIZATION OF THE BUREAU OF PLANT INDUSTRY

AS OF JANUARY 1,1935

DIRECTOR

STAFF

PLANT INVESTIGATION DIV.

- AGRICULTURAL CHEMISTRY SEC.
- AGRONOMY SECTION
- HORTICULTURAL SECTION
- PLANT BREEDING SECTION
- FIBER RESEARCH SECTION
- SOIL TECHNOLOGY SECTION
- TOBACCO RESEARCH SECTION
- LOS BAÑOS ECONOMIC GARDEN

ASSISTANT DIRECTOR

OFFICE OF THE DIRECTOR

- GENERAL SERVICE SECTION
- ACCOUNTING & PROPERTY SECTION
- RECORDS SECTION
- REFERENCE LIBRARY & PUBLICATIONS SEC.

PLANT PEST & DISEASE CONTROL DIVISION

- ENTOMOLOGY SECTION
- PLANT PATHOLOGY SECTION
- FIELD CONTROL SECTION
- PLANT QUARANTINE SECTION

COMMITTEES

AGRICULTURAL EXTENSION DIV.

- FARMERS CONFERENCES & AGRI. FAIRS SEC.
- ANNUAL CROPS SECTION
- PERENNIAL CROPS SECTION
- RURAL IMPROVEMENT SECTION

PLANT PROPAGATION DIVISION

- SEED & PLANT DISTRIBUTION SEC.
- FARM MANAGEMENT SECTION
- AGRICULTURAL ENGINEERING SEC.

FIELD SERVICE

AGRO. DIST. NO. 1	AGRO. DIST. NO. 2	AGRO. DIST. NO. 3	AGRO. DIST. NO. 4	AGRO. DIST. NO. 5
ILOCOS NORTE, ILOCOS SUR, ABRA, LA UNION. HEADQUARTERS: BANTAY, ILOCOS SUR	BATANES, CAGAYAN, ISABELA AND NUEVA VIZCAYA. HEADQUARTERS: ILAGAN, ISABELA	MOUNTAIN PROVINCE HEADQUARTERS: BAGUIO MT. PROVINCE	NUEVA ECIJA, TARLAC AND PANGASINAN HEADQUARTERS: MUÑOS, N. ECIJA	MANILA, BULACAN, RIZAL, CAVITE & PALAWAN HEADQUARTERS: CITY OF MANILA
1. BANTAY PLANT PROPAGATION STATION BANTAY, ILOCOS SUR	1. ILAGAN TOBACCO STATION ILAGAN, ISABELA.	1. BAGUIO SEMI-TEMPERATE FRUIT STATION BAGUIO MOUNTAIN PROVINCE	1. MALIGAYA RICE STATION MUÑOZ, NUEVA ECIJA	1. INDUSTRIES MANGO STATION, RIZAL 2. BALINTAWAK NURSERY CALOOCAN, RIZAL CENTRAL EXPERIMENT STA. MALATE, MANILA

AGRO. DIST. NO. 6	AGRO. DIST. NO. 7	AGRO. DIST. NO. 8	AGRO. DIST. NO. 9	AGRO. DIST. NO. 10
BATAAN, PAMPANGA AND ZAMBALES HEADQUARTERS: LAMAO, LIMAY, BATAAN	BATANGAS AND MINDORO HEADQUARTERS: LIPA, BATANGAS	TAYABAS, LAGUNA AND MARINDUQUE HEADQUARTERS: LUCENA, TAYABAS	ALBAY, SORSOGON, C. NORTE & C. SUR HEADQUARTERS: MORIONES, PILI, C. SUR	SAMAR, LEYTE AND MASBATE HEADQUARTERS: GANDARA, SAMAR
1. LAMAO HORTICULTURAL STATION LAMAO, BATAAN	1. TANAWAN CITRUS STA. TANAWAN, BATANGAS 2. LIPA COFFEE-CITRUS STA. LIPA, BATANGAS 3. HALCON RUBBER SUB-STA. BACO, MINDORO	1. LOS BAÑOS ECONOMIC GARDEN LOS BAÑOS, LAGUNA	MORIONES PLANT PROPAGATION STATION PILI, CAMARINES SUR	GANDARA SEED FARM GANDARA SAMAR

AGRO. DIST. NO. 11	AGRO. DIST. NO. 12	AGRO. DIST. NO. 13	AGRO. DIST. NO. 14	AGRO. DIST. NO. 15
ILOILO, CAPIZ, ANTIQUE & ROMBLON HEADQUARTERS: LA PAZ, ILOILO	OCCIDENTAL & ORIENTAL NEGROS HEADQUARTERS LA CARLOTA, OCC. NEGROS	CEBU & BOHOL HEADQUARTERS: CEBU, CEBU	NORTH MINDANAO, (SURIGAO, AGUSAN, BUKIDNON, LANAO, OCC. & OR. MISAMIS) HEADQUARTERS CAGAYAN ORIENTAL, MISAMIS.	SOUTH MINDANAO (COTABATO, DAVAO ZAMBOANGA & SULU) HEADQUARTERS: PIKIT, COTABATO
1. LA PAZ PROPAGATION STATION LA PAZ, ILOILO	1. GRANJA SUGAR CANE STA. LA CARLOTA, OCC. NEGROS	1. MANDAUE SEED FARM MANDAUE, CEBU	1. GINGOOG LANZON RESERVATION GINGOOG, OR. MISAMIS	1. MARIDAGAO RUBBER STATION PIKIT, COTABATO